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INFANTILE CORTICAL HYPEROSTOSES

PRELIMINARY REPORT ON A NEW SYNDROME*

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IN 1939, one of us (J.C.) described the case of an infant with multiple cortical hyperostoses scattered in the tubular bones of the extremities and the ribs and clavicles whose clinical and laboratory findings did not seem to be consonant with any recorded disease.[3] The causal agent of the disorder was not determined but it was clear that the patient suffered neither from scurvy nor syphilis, infantile diseases in which multiple cortical thickenings are commonly found.

Since that time we have studied 3 additional patients with similar manifestations whose combined clinical and roentgen findings appear to constitute a new infantile syndrome. The principal features of the disorder include: onset in the early part of the first year; tender swellings in one or more of these sites—face and jaws, scapular regions, and extremities; and multiple scattered hyperostoses demonstrated roentgenographically in bones adjacent to the tender swellings and also in several other bones whose overlying soft tissues appear to be normal, clinically and roentgenographically.

CASE REPORTS

CASE 1 (B.H. No. 547,799). The patient, a male infant, was born on February 12, 1938. The mother had enjoyed normal health during the pregnancy and apparently had eaten foods which contained adequate vitamins. Delivery was spontaneous; birth weight was 3.2 kilograms. During the first ten days he sucked at the breast and thereafter received a variety of formulas made from whole milk, Biolac or evaporated milk. Orange juice, 10 drops daily, was begun during the fourth week and was gradually increased until the seventh week, after which he received 1 tablespoonful daily. Hot water was often added to the orange juice and much of the juice was said to have been vomited. Oleum percomorphum, 5 drops daily, was given from the fourth to the ninth week and Drisdol, 3 drops daily, from the ninth to the twelfth week.

The infant thrived until the seventh week when he became hyperirritable and feverish; thereafter he lost his appetite, failed to gain and cried out when the left leg was handled. A few days after the onset of hyperirritability and fever, both legs became tender and the lower extremities showed little spontaneous movement. Moderate fever persisted until hospital admission, reaching a level of 101°F.

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daily. Four days before admission the left leg became visibly swollen. Swellings were not recognized in the cheeks or jaws.

In the physical examination made at admission when the infant was twelve weeks of age, the temperature was found to be normal and he did not appear to be ill. The extremities moved freely. The swelling of the left thigh was still visible but was not tender and showed no signs of inflammation. There were no hemorrhages in the conjunctivae or mouth. The lower pole of the spleen was palpable. The multiple skeletal thickenings revealed later by roentgen examination were not recognized in the first physical examination. The Mantoux test gave a negative reaction.

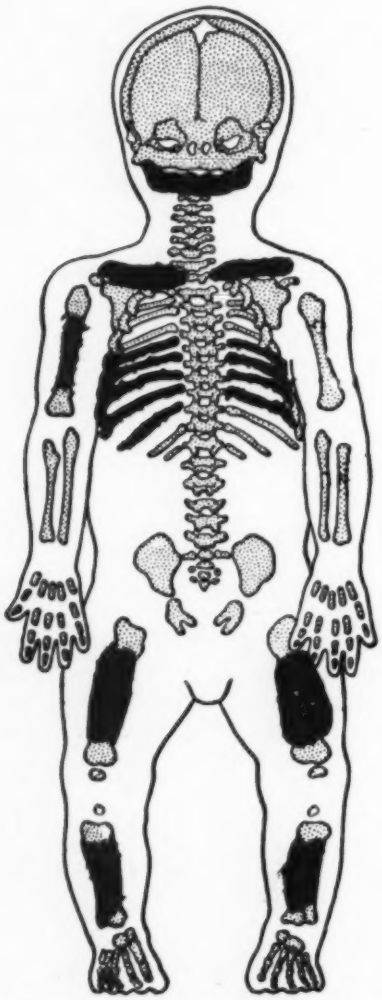
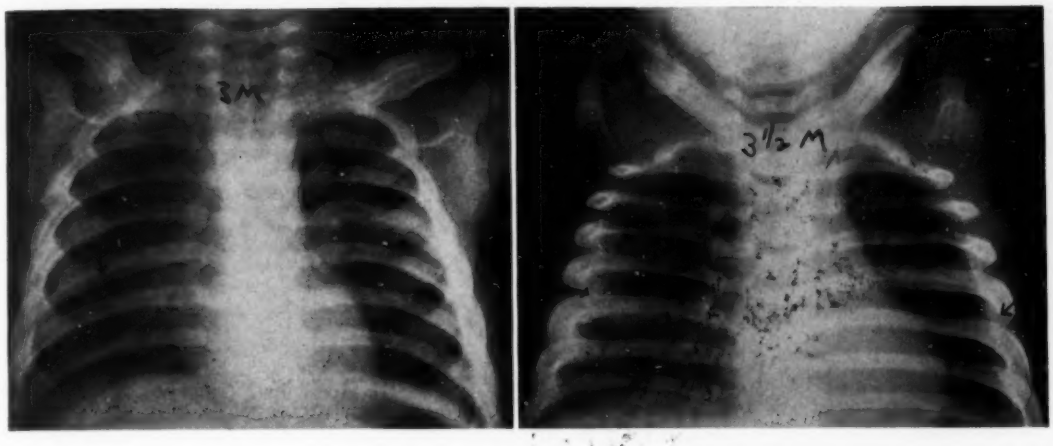


FIG. 1. Case 1. Spot map of the skeleton in which the heavily shaded bones are the sites of hyperostoses. The most marked changes are located in the clavicles and femurs. The epiphyseal ossification centers and the round bones are not affected.

The Kahn test for syphilis was negative on the infant's blood and cerebrospinal fluid and on the mother's blood. The number of red blood cells and the hemoglobin content were normal, 4.7 million per cu. mm. and 71 per cent respectively; in several examinations the average leukocyte count was 13,000 per cu. mm. and the polymorphonuclears varied between 15 and 57 per hundred, the lymphocytes between 40 and 84 per hundred and the monocytes between 1 and 8 per hundred. The bleeding and clotting times were normal; the blood platelets averaged 600,000 per cu. mm. Determinations of ascorbic

FIG. 2. Case 1. Roentgenogram of the lower extremities at fourteen weeks of age. Massive irregular cortical thickenings are visible in both tibias and the left femur; their external margins are irregular. A smaller smooth hyperostosis covers the right femur. The cortex in the terminal segments of the shafts, however, is not thickened and the metaphyses show no changes suggestive of scurvy. There are no scorbutic changes in the epiphyseal ossification centers. The soft parts of the left thigh are thickened. The overlying subcutaneous fat, however, is not involved.



A *B*

Fig. 3. Case 1. Roentgenograms of the thorax; *A*, at twelve weeks of age; *B*, at fourteen weeks. In *A* thick hyperostoses surround the clavicles; also several ribs on both sides are thickened and sclerotic. There is, however, no roentgen evidence of pleural exudate at this time. In *B* the pleuras are thickened on both sides. The liquid removed from the right pleural space contained 500 monocytes per cu. mm.; no bacteria were found in smears or cultures.

acid disclosed low concentrations in the blood and high concentrations in the urine. The excretion of large amounts of ascorbic acid in the urine was interpreted to be inconsistent with active scurvy. Tests for heterophile antibodies in the blood resulted in negative reactions as did agglutination tests for the typhoid-dysentery group of bacteria (Shiga, Flexner, Sonne, paratyphoid A and B), and for *B. melitensis* and *B. abortus*. Samples of blood cultured in aerobic and anaerobic media yielded no bacterial growth. In several examinations the sedimentation rate of the erythrocytes varied from 33 to 99 mm. during one hour.

The blood serum contained normal quantities of calcium and phosphorus. The serum albumin and globulin were present in normal amounts and in normal proportions. There was 164.3 mg. of total cholesterol in 100 cc. of blood; the cholesterol ratio (ester-free) was 2.12. Resistance of red blood cells to salt solutions was normal.

The urine was normal in four examinations. Occasional erythrocytes were found in the microscopic examinations but there was no significant hematuria.

Pathogens were not recovered in cultures of the feces and five guaiac tests for blood resulted in negative reactions.

Roentgenographic examination of the skeleton disclosed scattered hyperostoses in several bones (Fig. 1): in the mandible, both clavicles, the right humerus, several ribs, both femurs and both tibias. The most conspicuous changes were found in the femurs, which were surrounded by considerable soft tissue swelling (Fig. 2). There were no changes suggestive of

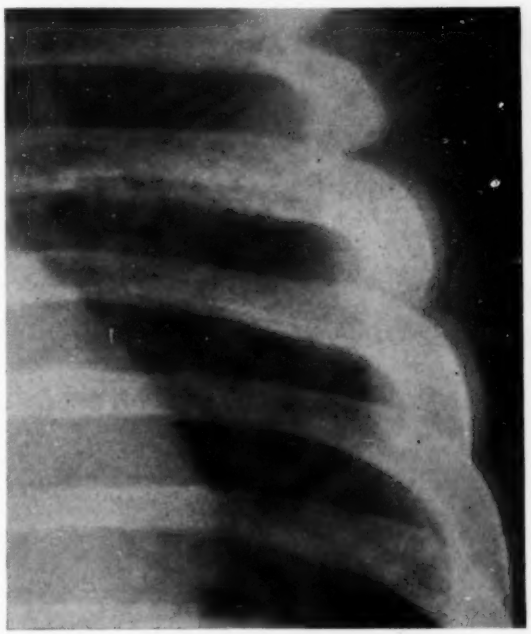


Fig. 4. Case 1. A more detailed view of the costal and pleural changes in Figure 3*B*. The costal thickenings are most pronounced in the lateral arcs but the posterior segments are also thickened.

Fig. 5. Case II. Photograph of the face at six months of age—four months after the first appearance of the facial swellings. The right cheek and the right side of the jaw are swollen.

scurvy in the metaphyses or the ossification centers in the epiphyses.

The patient remained in the hospital for four weeks. During the second hospital week when the infant was fourteen weeks of age and seven weeks after the appearance of the initial symptoms, pleural exudate appeared in both pleural spaces (Fig. 3 and 4). The pleural fluid which was removed from the right pleural space contained 500 monocytes per cubic millimeter; no bacteria were found in direct smears or cultures of this liquid. Fever accompanied the appearance of pleuritis; the temperature increased daily to levels of 100 or 101° F., during the interval between the tenth and twenty-third hospital days, after which the fever subsided and did not recur.

A piece of the thickened right clavicle was removed during the third hospital week. Microscopic examination disclosed only hyperplasia of normal lamellar bone. There was no evidence of old or recent inflammatory exudate or subperiosteal hemorrhage.

The course of the disease was benign after the patient came under our observation. Save for the development of monocytic pleuritis and its concurrent short febrile episode, there were no new active clinical manifestations. The swelling of the left thigh subsided gradually and never showed signs of suppuration. The infant was free from symptoms when he left the hospital at sixteen weeks of age and has remained asymptomatic. The Kahn test for syphilis was repeated at five months of age and resulted in a non-syphilitic reaction. At this time the bone lesions were still visible roentgenographically but showed distinct improvement in comparison with the earlier findings. In an examination made when the patient was six years, eight months of age he was normal clinically and his skeleton appeared to be normal roentgenographically.

Case II (B.H. No. 591,351). The patient, a male infant, was born on May 3, 1939, after cesarean section. He weighed 4 kilograms at birth. The pregnancy was uneventful and the maternal diet during gestation had apparently been adequate. Blood tests on both parents gave non-syphilitic reactions. The infant was healthy and developed normally during the

Fig. 6. Case II. Photograph of the right forearm at six months of age—three months after the onset of tenderness and swelling of the forearms. The right forearm is diffusely swollen and the fullness of the right cheek is evident.

first two months. Orange juice was added to the diet at the end of the first month; 1 to 3 ounces had been taken daily. Cod liver oil was given daily after the third month. Ascorbic acid and viosterol were given after the onset of symptoms in daily dosages of 100 mg. and 15 drops respectively.

During the eighth week, tender swellings appeared in both cheeks and both sides of the jaw and a low grade fever developed. The family physician suspected that the patient was suffering from bilateral parotitis. The swellings and fever persisted. During the twelfth week the temperature increased, reaching levels of 101 to 103°F. daily; at the same time the swellings of the cheeks enlarged, extending upward as far as the orbits. After admission to another hospital, the fever continued for several days when it suddenly subsided and simultaneously the facial swellings began to diminish. Roentgenograms of the jaw were interpreted as normal and Kline's test on the blood gave a non-syphilitic reaction.

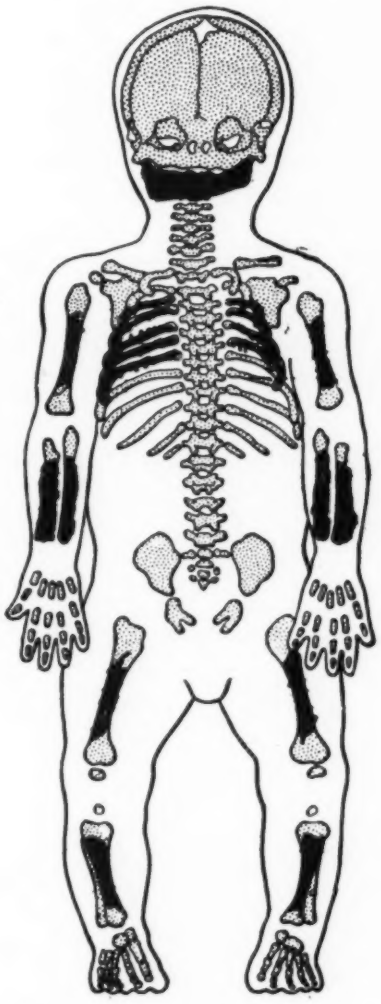


Fig. 7. Case II. Spot map of the skeleton in which the heavily shaded bones are the sites of cortical thickenings. In contrast to Case I, the clavicles are not affected and the forearms are the site of the largest hyperostoses in the extremities.

Fig. 8. Case II. Massive cortical thickenings of the right radius and ulna at five months of age; the bones of the hand are not involved. The absence of metaphyseal changes suggestive of scurvy is noteworthy. Similar changes were found in the left forearm.

During the seventeenth week of life tender swelling of the right side of the face recurred and both forearms became extensively swollen and tender. At readmission to the same other

Fig. 9. Case II. Lateral roentgenogram of the mandible at four months of age, two months after the first appearance of facial swelling. The mandible is diffusely thickened and is sclerotic. There is no evidence of bone destruction.

hospital, the only abnormal clinical findings were the aforementioned swellings which showed no increase in local heat, no hyperemia and no evidence of subcutaneous hemorrhage. The temperature at this time was normal. A Rumpel-Leede test for capillary fragility gave a normal reaction. The urinary findings were normal; there was neither gross nor microscopic hematuria. The erythrocytes were decreased to 2.2 million per cu. mm.; the hemoglobin measured 63 per cent. The leukocytes numbered 6,000 per cu. mm.; 51 per hundred were polymorphonuclears. Serum calcium, serum phosphorus, and phosphatase were normal. Roentgenograms made when the patient was seventeen weeks of age showed massive cortical thickenings of the ulnas and radiuses, the sternal ends of the ribs and the mandible. Similar but less pronounced changes were demonstrated in the humeri, femurs and tibias. During the latter part of his six weeks' residence in that hospital the temperature ranged irregularly between 98 and 101°F. and the swellings of the forearms decreased slightly. He ate and slept normally and was comfortable when not disturbed by handling.

At five and one-half months of age the patient was transferred directly to the Babies Hospital. On admission he was found to be well nourished and appeared to be comfortable. The jaw and both forearms were, however, still visibly swollen (Fig. 5 and 6). The mandibular swelling was smooth and stony hard; it was most prominent at the angle of the mandible on the right side. There was no fullness in the parotid region. The regional lymph nodes in the submaxillary region and the neck were not enlarged and the mucous membranes of the conjunctivae and mouth were normal. The diffusely swollen right forearm was of a firm consistency and was non-tender. There was some limitation of motion of the left forearm but there was no tenderness or pain and the movements in the remainder of the body were normal. The right wrist was 13 cm. in circumference and the left wrist 11.5 cm. In the laboratory examinations the blood hemoglobin, the blood cells, urine, serum calcium and phosphorus, and sedimentation rate of erythrocytes were all found to be normal and Kline's test on the blood resulted in a non-syphilitic re-

Fig. 10. Case II. Dorsoventral projection of the right hemithorax which shows pleural thickening and costal cortical hyperostoses at five months of age.

action. The serum contained 22.6 Bodansky units of phosphatase.

Roentgenographic examination of the skeleton disclosed multiple hyperostoses with the distribution depicted in Figure 7. In contrast to Case 1, the largest hyperostoses were in the forearms (Fig. 8), and the clavicles were not affected. The changes in the mandible (Fig. 9), on the other hand, were much greater than in Case 1. Heavy pleural shadows similar to those seen in Case 1 were demonstrated on the right side (Fig. 10). Thoracentesis was not done and the nature of the pleural exudate was not determined.

No new manifestations developed during a hospital residence of eighteen days; the temperature was normal. The swellings of the forearms were subsiding at the time of discharge; at no time did signs of inflammation appear in these lesions. There was no recurrence of signs or symptoms later. The roentgenographic changes in the skeleton gradually diminished in size and density but were still visible in the radiuses and ulnas at ten months of age. The clinical and roentgenographic findings were normal in a follow-up examination at five years and five months of age.

Case III (B.H. No. 749,486), a male infant, was born on February 24, 1944, after a normal spontaneous labor and weighed 2.6 kilograms. The gestation was uneventful and the ante partum diet was adequate and balanced. During the first two months of life, the infant was healthy and gained normally. Orange juice and oleum percomorphum were given after the second month.

During the eighth week the "nose became stuffy"; fever was not recognized at this time and there were no constitutional symptoms. After several days the "nasal stuffiness" disappeared. During the tenth week, the mother observed that the infant's right cheek was swollen. One week after the appearance of this swelling the baby became hyperirritable, restless and refused food; the temperature was not taken but he did not appear to be feverish to the parents. The facial swelling and hyperirritability persisted for several days when roentgenograms of the jaws were made by the family dentist, who referred the patient to another hospital for investigation of a tumor of the mandible.

In the admission physical examination there, when the patient was twelve weeks of age, the abnormal findings included generalized pallor and swelling of the right side of the jaw. A hard mass attached to the right side of the mandible was palpable. Examination of the blood disclosed that the hemoglobin was reduced to 46 per cent and the erythrocytes to 2.3 million per cu. mm.; the leukocytes numbered 14,000 per cu. mm., there were 64 polymorphonuclears per hundred, 30 lymphocytes,

Fig. 11. Case III. Photograph which shows the swelling of the right cheek at four and one-half months of age, two months after its first appearance.

4 monocytes and 2 myeloblasts. Occasional leukocytes were found in the urine but no red blood cells. The serum calcium and phosphorus were normal; there were 24.2 units of alkaline phosphatase. Irregular elevations of temperature occurred in the hospital; recurrent fever of 100° F. developed and lasted irregularly for periods of forty-eight or seventy-two hours. Approximately one week after admission, a swelling of the left scapular region was seen for the first time. Roentgen examination revealed hypertrophy and sclerosis of the right side of the mandible, the left scapula, the left clavicle and cortical thickenings of several ribs and in

the tubular bones of the upper and lower extremities. The pleural layers on the lateral margin of the left lung were thickened.

At four months of age, six weeks after the first appearance of the facial swelling, the patient was admitted to the Babies Hospital. He was found to be well nourished and had a waxy

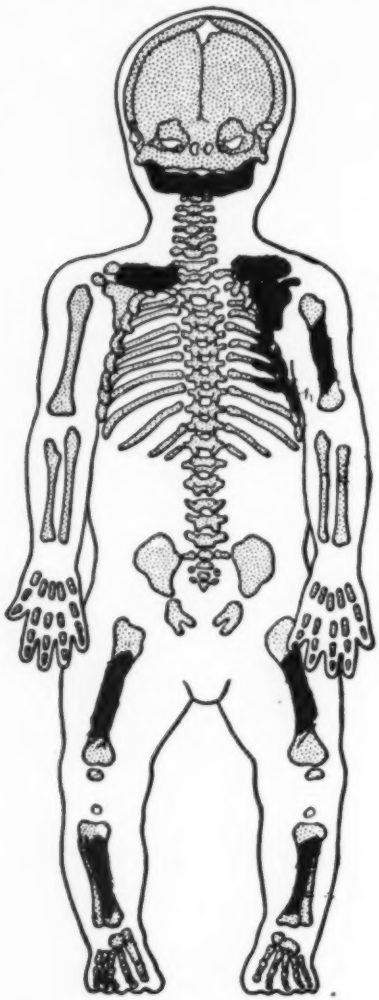


Fig. 12. Case III. Spot map of the skeleton in which the shaded bones are the sites of cortical hyperostosis. The hyperostoses were greatest in the mandible, clavicles and left scapula.

papular eruption of the face which resembled seborrheic dermatitis. The right cheek and right side of the mandible were swollen (Fig. 11). The swellings were not tender at this time and the mandibular movements were not limited. The left clavicular and scapular regions were swollen but were not tender. The movements of the extremities were free and there was no swelling or tenderness in the arms or legs. The results in blood count, the urinary findings, bleeding time, clotting time and prothrombin time were all normal. The serum phosphatase was elevated to 45.8 Bodansky units; the serum calcium and phosphorus were normal. Culture of the blood yielded no bacterial growth. Kline's test on the blood gave a non-syphilitic reaction and the tuberculin test on the skin was negative. Agglutination tests of the blood for the typhoid dysentery group of bacteria resulted in no reaction and also for the organisms of brucellosis and cholera. In the roentgen examination, hyperostoses were demonstrated in the mandible, left scapula and clavicles (Fig. 12 and 13). The costal changes and the pleural thickening which were visible in roentgenograms made earlier at twelve weeks of age had disappeared completely.

The patient remained in the hospital for three weeks and was asymptomatic during this period. The mandibular and scapular swellings persisted unchanged. During the third hospital week a portion of the left scapula was removed; in the microscopic examination hyperplasia of normal bone was found. There was no evidence of inflammatory exudate or subperiosteal hemorrhage.

The swelling of the face and shoulder gradually diminished and had disappeaed completely at one year of age. In the roentgenograms made at this time the shadow of the left scapula was still slightly enlarged; but the patient was normal clinically.

Case IV (B.H. No. 612,819), a male infant, was born after a normal gestation and labor on January 25, 1940; he is reported to have weighed 4.8 kilograms. A formula made from evaporated milk was started at birth; cod liver oil with oleum percomorphum, one teaspoonful daily, and ascorbic acid, 25 mg. daily, were fed soon after birth but the exact time of beginning them was not ascertainable.

At birth a soft swelling was seen in the anterior portion of the neck which was thought to be a lipoma by the family physician. This cervical swelling is said to have gradually diminished in size during the first few days of life.

At about two weeks of age, swelling of the right scapular region and limitation of motion of the right arm at the shoulder were noted. The scapular mass was firm and tender but

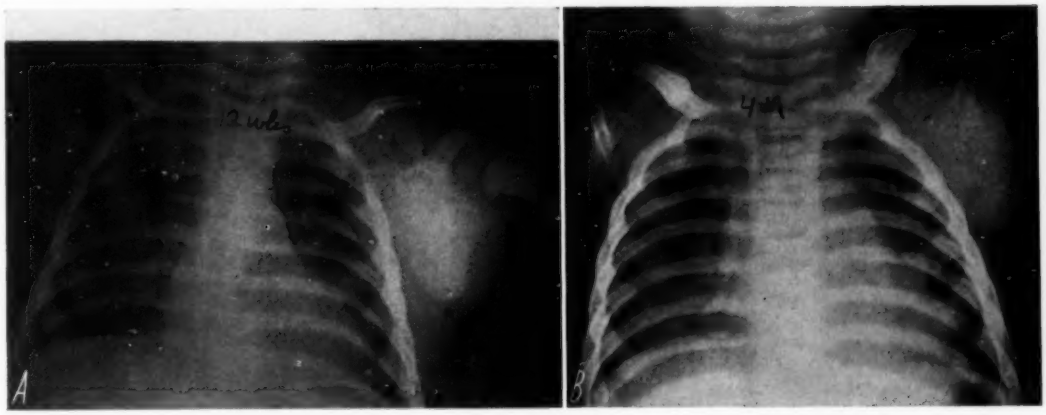


Fig. 13. Case III. Roentgenograms of the thorax at twelve weeks of age, *A;* and sixteen weeks, *B*. In *A* the soft parts in the left scapular region are thickened and the left scapula is enlarged and sclerotic but the clavicles appear to be normal. This roentgenogram was made when the scapular swelling was first recognized clinically. In *B*, the swelling and sclerosis of the left scapula has increased; in contrast to *A*, both clavicles are thickened and sclerotic. In a later roentgenogram, not shown, made at one year of age, the clavicular changes had disappeared completely but the sclerosis of the left scapula was still evident.

showed no signs of inflammation. The right arm was never completely paralyzed and there was considerable fluctuation in the movement of this extremity from day to day. A roentgen examination at ten weeks of age showed the right scapula to be enlarged and sclerotic but there were no abnormalities in the clavicles or ribs. Swelling and sclerosis of the left side of the mandible were visible in this roentgenogram and the right side of the diaphragm was elevated. During the tenth week the right shoulder was put in a cast which held the right arm in abduction. After about one month, the cast was removed and the motion of the right arm was said to have been greatly improved.

Three weeks after birth the left cheek and the left side of the jaw became swollen, tender and hard; and the patient had much difficulty in sucking food from the bottle. The swellings were not hyperemic and there was no increase in local heat. Fever, if present, was not detected by the mother. After about one week the left-sided facial swelling began to subside. During the sixth week of life the right cheek and the right side of the jaw became tender and swollen; this swelling began to subside after one week without any evidence of suppuration in the same fashion as the precedent left-sided facial swelling had decreased. Facial swellings of similar nature recurred twice on the left side and once on the right side during the first five months. There apparently were no associated constitutional symptoms; fever was not recognized at any time and there were no manifest disturbances of the alimentary, respiratory, genitourinary or nervous systems.

At five months of age, the patient was admitted to the Babies Hospital, four days following the appearance of the last of the recurrent swellings of the face. This swelling, on the right side, had already begun to subside at the time of admission. Both cheeks and the right side of the jaw were enlarged but not tender. The tissues in the right side of the neck were also thickened. Over the right scapula the tissues were swollen and indurated. The movements of the right arm were normal and its muscular power approximated that in the left arm. No information of positive diagnostic value was obtained from the laboratory examinations. The cellular elements in the blood were normal in number and structure. There were no abnormal urinary findings; there was no evidence of hematuria. The quantities of nonprotein-nitrogen, calcium, phosphorus and phosphatase in the blood were normal. Kline's blood test gave a non-syphilitic reaction and the Mantoux test caused no significant changes in the skin.

Roentgen examination disclosed massive hyperostoses in the mandible, right clavicle, right scapula and there were delicate lamellated thickenings of the right humerus and both femurs (Fig. 14). The left side of the mandible showed marked swelling and heavy sclerosis (Fig. 15). The right scapula and right clavicle

were also swollen and sclerotic, although their counterparts on the left side were unaffected (Fig. 16). In the roentgenoscopic examination, the right side of the diaphragm was elevated and partially paralyzed; the amplitude of its excursion was reduced to approximately 1 cm.

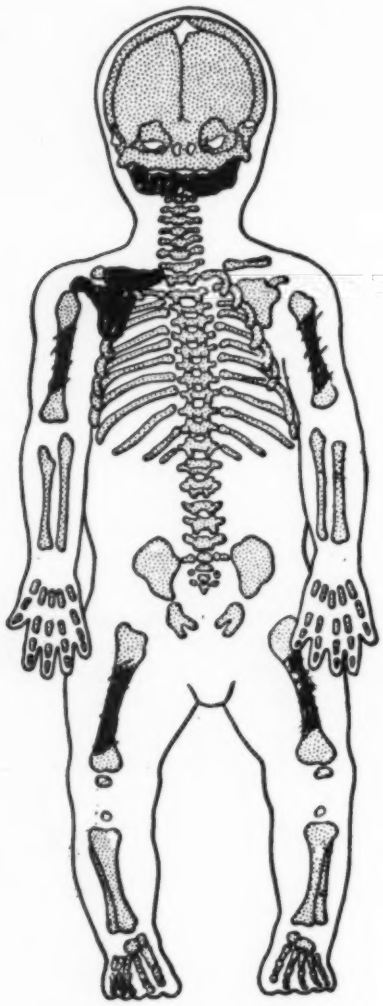


FIG. 14. Case IV. Spot map of the skeleton in which the heavily shaded bones are the sites of hyperostosis. The most marked changes are in the left side of the mandible, the right clavicle and right scapula.

In the tissues removed from the right scapular region a satisfactory specimen of bone was not obtained but in the muscular bundles attached to the perichondrium of the scapula many vacuolated fasciculi were seen.

The patient was asymptomatic during a hospital residence of three weeks save for fever during a few days which was associated with an upper respiratory infection. No new swellings appeared.

In a follow-up examination at four years and nine months, it was found that there had been no recurrence of the swellings and that the patient had enjoyed normal health during the interval of four and one-half years since the hospital observations. In the physical examination, however, the face was found to be asymmetrical; the left side of the face was larger than the right and the left side of the jaw was visibly enlarged (Fig. 17). In the roentgen examination the left side of the mandible was larger and more opaque than the right side and the left zygomatic bone was enlarged and sclerotic. The clavicles and scapulas were normal. The right side of the diaphragm was still elevated as in the earlier examinations.

FIG. 15. Case IV. Roentgenogram of the mandible at five months of age, lateral oblique projection. The left side of the bone is sclerotic and diffusely thickened.

COMMENT

Maternal and Birth Histories. In all cases the mothers apparently enjoyed normal health and ate normal foods in normal quantities. None of the patients was born prematurely. In 3 cases the labors were

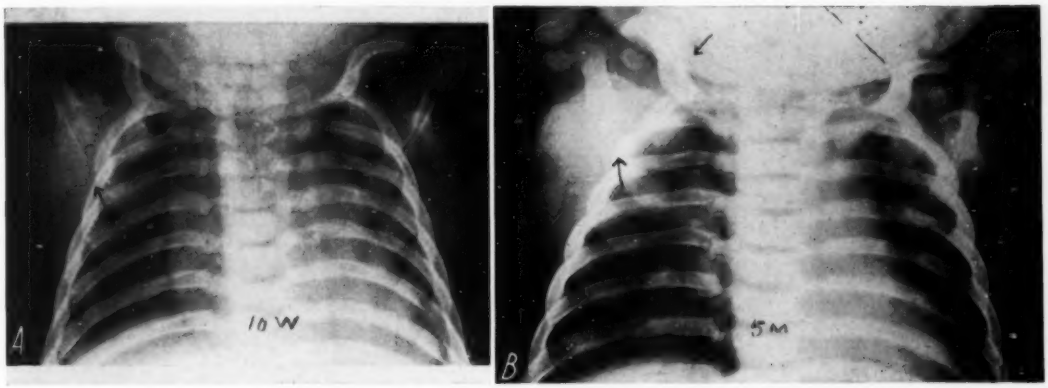


Fig. 16. Case IV. Frontal roentgenogram of the thorax at ten weeks of age, *A*, and five months, *B*. In *A*, the right scapula is already affected but the right clavicle is not abnormal. In *B*, the changes in the right scapula have increased and the right clavicle is now markedly thickened.

spontaneous and normal; in Case II the patient was delivered after uncomplicated cesarean section. There is no evidence that prenatal deficiency of vitamins or obstetrical trauma was the cause of the infantile disturbances.

Onset. Much of the information concerning the onset is uncertain because most of the observations were made by the parents. It is certain, however, that the first manifestations became active during the first three months of life (Case I, seventh week;

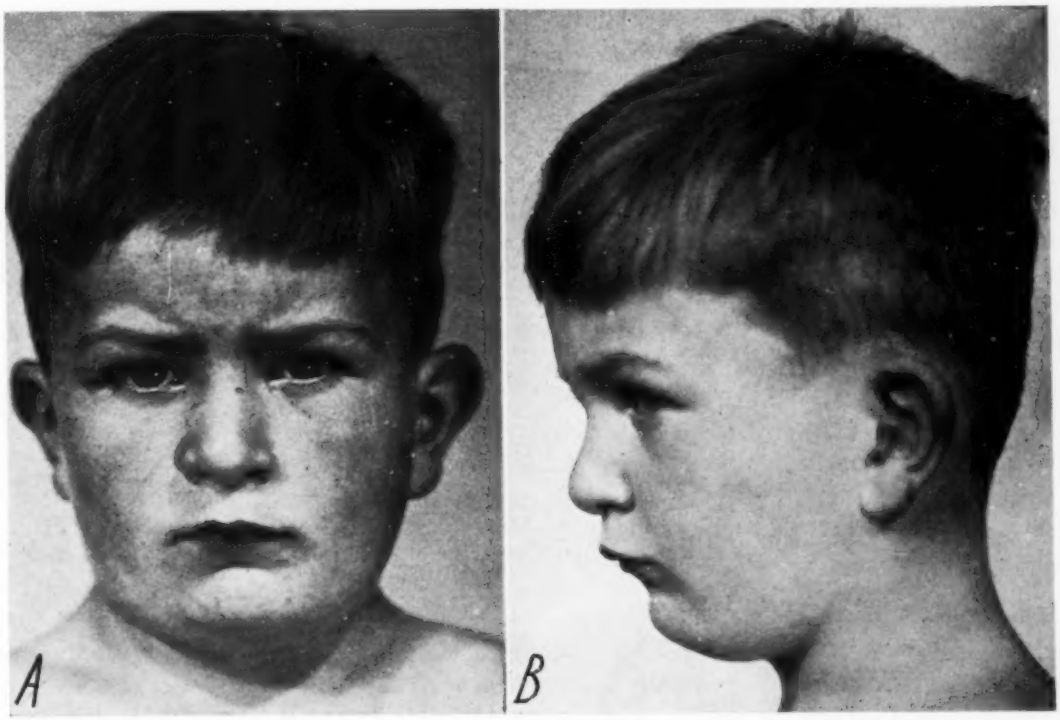


Fig. 17. Case IV. Photographs at four years and nine months of age; *A*, frontal view; *B*, left lateral view. The face is asymmetrical owing to swelling of the left side of the face and the left submaxillary region. The facial swelling first appeared during the third week of life.

Case II, eighth week; Case III, tenth week; Case IV, second week). In every case the primary complaint was the appearance of tender swellings—in the thigh in Case I, in the face in Cases II and III, and in the scapular region in Case IV. Fever developed at the onset in Cases I and II; it was not recognized at the onset in Cases III and IV but may have been overlooked because temperatures were not measured. In the first phase of the disease, the swellings were tender but they did not show increased heat and they did not appear to be hyperemic. In Case IV, dysphagia appeared simultaneously with the facial swellings and limitation of movement at the right shoulder developed concurrently with the appearance of the swelling in the right scapular region. Prodromal symptoms were meager; fever and hyperirritability in Case I and stuffiness of the nose in Case III. Nasal obstruction in this case is the only manifestation suggesting that respiratory infection was present at the time of onset. Laboratory examinations were not made at the time of onset. During the second week of the disease in Case III, a blood count disclosed a moderately severe anemia.

Clinical Manifestations. In contrast to the multiple massive soft tissue swellings and the extensive scattered hyperostoses, there was a striking paucity of constitutional and systemic manifestations in all stages of the disease. Fever occurred in 3 cases. In Case I a low grade irregular fever persisted from the onset at the seventh week until the twelfth week and then recurred when bilateral sterile pleurisy developed during the fourteenth week. In Case II the fever was more severe—it began at the onset during the eighth week of life, reached levels of 103° F. and persisted irregularly until the patient was five and one-half months of age. In this case the temperature levels were highest when the swellings first made their appearance and when they were increasing in size. In Case III irregular mild fever was recorded in another hospital two weeks after the onset of facial swellings although fever had not been recognized earlier at home. In Case IV, who had a most severe clinical course and heavy recurrent hyperostoses, fever was never recognized during any stage of the disease either at home or in the hospital.

Visible and palpable tender swellings developed in all patients and they are the principal clinical components of the disorder. We did not have the opportunity of observing the swellings at onset or in the early phases when they were enlarging. One would opine from the parents' description that the swellings developed exceedingly rapidly—"came up over night"—in contrast to their slow subsidence. At no time was there any clinical evidence of hemorrhage or suppuration in these tumors. All were of a firm consistency early and became harder later. In the face, the soft tissues of the cheek anterior to the parotids were swollen as well as the lower jaw. No changes were detected in the adjacent mucosa of the mouth, and the overlying skin did not appear to be affected.

Swellings developed in the left leg in Case I; this is the only case in which facial swellings were neither visible nor palpable —notwithstanding, mandibular thickening was demonstrated roentgenographically. Pronounced swellings made their appearance in the face and both forearms in Case II; the former preceded the latter by nine weeks. These facial swellings fluctuated rapidly in size and disappeared and recurred several times. In Case III facial swelling developed during the tenth week and one week later the left scapular region became swollen. In Case IV in contrast, the right scapular region became swollen at two weeks and at three weeks a swelling appeared in the left side of the jaw. In this case, weakness of the right arm developed simultaneously with the appearance of the scapular swelling and considerable dysphagia was associated with the onset of the facial swellings. It should be emphasized that there were no clinical signs of swelling in many other sites—in the clavicles, ribs and long bones where hyperostoses were

demonstrated roentgenographically. It is therefore evident that only the largest and tender lesions have been detected clinically and the majority of hyperostoses were overlooked until roentgen examinations were made; and it seems probable that many mild cases without conspicuous clinical signs have not been subjected to roentgen studies and have not been recognized.

Laboratory Findings. All of these patients remained at home during the earliest stage of the disease and no laboratory observations were made until considerably later. The details of the later laboratory findings are given in the case reports; little information of positive diagnostic value was obtained from them. Serological tests for syphilis gave non-syphilitic reactions in all cases. The quantitative studies of the concentrations of ascorbic acid in the blood and the urine in Case 1 did not support the diagnosis of scurvy. Agglutination tests on the blood and cultures of the blood disclosed no findings suggestive of bacterial infection. Smears and cultures of pleural exudate in Case 1 yielded no bacteria. Examination of the blood revealed no evidence of hemorrhagic disease and there was no hematuria.

Biopsies of affected bones in 3 cases showed only hyperplasia of the lamellar cortical bone; there was no evidence of inflammation or of subperiosteal hemorrhage. In both clinical and roentgen examinations, pronounced changes were demonstrated in the soft parts adjacent to the hyperostoses. We did not have the opportunity to make early biopsies of the soft tissue and bone when they might have been more informative.

Roentgen Findings. In the roentgen observations, scattered bones and their overlying soft parts were found to be thickened in all 4 cases, the pleurae thickened in 3 and the diaphragm paralyzed and elevated in 1 case.

In the skeleton, the basic roentgen change is an external thickening of the corticalis; this thickening was lamellated in many instances. The external margins of the cortical swellings were irregular in numerous bones (see Fig. 2, 3*A*, 8 and 13*B*). It is noteworthy that in the lower extremities the cortical thickenings do not extend the entire length of the corticalis but leave the terminal segments of the shafts unaffected (see Fig. 2). In contrast, the subperiosteal hemorrhage in scurvy and its subsequent cortical thickening begin directly on the end of the corticalis at the cartilage-shaft junction. In the unaffected as well as the affected bones the spongiosa, the metaphyses, the epiphyseal plates and the ossification centers in the epiphyses all were normal roentgenographically. In not a single bone were there metaphyseal spurs or fractures of the epiphyseal plates or the adjoining lattice. The changes in the bones, therefore, not only do not support the diagnosis of scurvy but the absence of all the basic scorbutic changes is convincing evidence that the skeletal lesions are not due to deficiency of vitamin C. It is clear that the soft tissue changes are confined to the neighboring muscular bundles and do not extend into the overlying subcutaneous fat. The soft tissue swellings evidently preceded the formation of the hyperostoses (see Fig. 13, *A* and *B*, and 16, *A* and *B*).

The incidence and the distribution of the skeletal and pleural lesions in 4 cases are shown in Table 1. The mandible was ex-

Table I

Case	Mandible	Clavicles	Scapulas	Ribs	Extremities	Pleura
I	++	++++(2)	o	++++	++++	++++
II	++++	o	o	++++	++++	++++
III	++++	++++(2)	++++	++++	++	++
IV	++++	++++(2)	++++	o	++	o

tensively swollen in all 4 cases; in Case I the mandibular swelling was not noted clinically and it was less extensive roentgenographically than in the other 3 cases. The absence of clinical swellings and tenderness in many regions where hyperostoses were demonstrated roentgenographically has already been commented on. Actually most of the hyperostoses would have been missed had the roentgen examination been limited to the sites of the clinical swellings. It is probably equally true that slight soft tissue swellings are readily overlooked both clinically and roentgenographically in this disease. We are not certain of the state of the facial bones other than the mandible because they were not adequately visualized roentgenographically.

The clavicles exhibited roughened cortical thickenings in 3 cases which appeared to be similar to those in the tubular bones of the extremities. Tenderness and pain were not associated with the clavicular lesions.

The massive involvement of the scapulas in Cases III and IV was a conspicuous and surprising finding. Only one scapula was affected in each of these patients and in each of them the hyperostoses in the long bones were not pronounced although their mandibular lesions were marked. The scapular changes appear to be due to cortical hyperplasia as in the other bones.

The ribs showed multiple involvement in Cases I, II and III. There was no clinical evidence of costal disease in any of these patients. It is possible that costal changes also developed in Case IV but were not demonstrated because roentgenograms were taken at too long intervals. In Case III the costal changes were not visible in the twelfth week, were clearly visible in the thirteenth week, but had disappeared completely in the seventeenth week. The costal thickenings were multiple in Cases I, II and III; and were bilateral in Cases I and II.

The greatest changes in the extremities were found in the legs in Case I and the forearms in Case II. The external margins of the largest hyperostoses were irregular in contrast to the smooth external margins of most of the smaller hyperostoses. As previously stated, the hyperostoses in the bones in the extremities were minimal in both cases in which scapular hyperostoses were identified.

Pleural exudate of sufficient magnitude to be visualized roentgenographically developed in Cases I, II and III. It is noteworthy that pleural exudate was demonstrated in the 3 cases in which costal thickenings developed but was not seen in Case IV in which costal hyperostoses also were not visualized. The close relationship of the pleural exudation and costal hyperostosis is also shown by the fact that the pleural exudate was bilateral in the 2 cases in which the costal lesions were bilateral (Case I and II); unilateral, left-sided pleurisy developed in Case III and the costal disease was also unilateral and left sided. The pleurisy did not develop concurrently with the other bone lesions, however. In Case I pleural exudate appeared seven weeks after the initial symptom of pain and swelling of the left thigh.

The right side of the diaphragm was found to be elevated and partially paralyzed in Case IV in the first roentgenoscopic examination. It is possible that this lesion developed at birth and was due to obstetrical injury to the phrenic nerve[9] or was of prenatal origin and was caused by pinching of the phrenic nerve between the fetal spine and shoulder girdle.[1] The associated weakness of the right arm may have been due to birth injury to the brachial plexus. The parents, however, were certain that the movements of the right arm were normal until two weeks after birth when the right-sided scapular swelling appeared. Perhaps the paralysis of the diaphragm and the weakness of the arm resulted from pressure on the phrenic nerve and brachial plexuses, respectively, by the large soft tissue swelling which developed in the right shoulder and right side of the neck during the second week of life. The weakness of the arm gradually improved and disappeared; the diaphragmatic weakness per-

sisted and was still present when the patient was four years and nine months of age.

The clinical and roentgen pictures of this disorder are probably more protean than the findings in the first 4 patients indicate.[7] Undoubtedly study of more patients will provide many modifications of our current concepts and add some new features. Already we have data on 3 additional patients who showed many findings similar to the 4 described above and it is likely that all 7 were affected by the same disease. In 1 case the clinical and roentgen swellings were limited to the face and mandible; treatment with sulfathiazole was completely ineffective—the fever persisted and mandibular swellings developed and extended during the administration of sulfathiazole. In a second the onset occurred during the eighteenth month of life, and the mandible and face were unaffected although extensive hyperostoses were found in the clavicles, ribs and tubular bones of the extremities including the metatarsals. In a third patient studied by Dr. Bruce Chown of Winnipeg, Canada, serial roentgen examinations early in the disease demonstrated clearly that the soft tissue swellings preceded the hyperostoses; in this case the swellings recurred in the face after and during the administration of large quantities of ascorbic acid.

Course and Duration. The active manifestations subsided completely after several weeks and there were no serious complications. The only sequelae occurred in Case IV—persistent facial swelling and diaphragmatic paralysis at four years and nine months (see Fig. 17). The fever was irregular and inconstant. In different patients the magnitude of the fever varied markedly from high long-sustained febrile episodes in Case II to absence of fever in Case IV. Fever recurred synchronously with the appearance of pleurisy in Case I; the histories suggest that fever also recurred or increased at the same time the facial swellings recurred in Case II. The swellings appeared suddenly, enlarged rapidly and subsided gradually after many weeks; they were tender only during the early phase of swelling. The abrupt onset of the swellings is not unlike the sudden appearance of tumors caused by angioneurotic edema; there was, however, no pruritus and no vesiculation or other associated allergic phenomena.

The course of the pleurisy could be followed only in Case I. Fever recurred at the time the pleural exudate was identified roentgenographically and persisted for thirteen days. There were no diagnostic physical signs or symptoms nor was there associated exacerbation of the swelling of the thigh.

The cortical thickenings gradually diminished and disappeared completely after several months; the skeletons were normal roentgenographically in the late follow-up examinations except in the mandible of Case IV. The marginal irregularities which were present early disappeared as the hyperostoses became smaller. There were surprisingly few "transverse lines" in the later roentgenograms.

Differential Diagnosis. During the study of these patients several diagnoses were entertained but none seems tenable after evaluation of all the findings. Scurvy can be ruled out on practically all counts—onset during first weeks of life, adequate intake of vitamin C by both mothers and infants, facial swellings which recurred during and after adequate administration of vitamin C, lack of hematuria, and in the roentgenograms absence of metaphyseal and epiphyseal changes and the presence of mandibular hyperostoses.

The clinical manifestations were not characteristic of syphilis; the serologic reactions were non-syphilitic; mandibular involvement and absence of signs of osteochondritis in the presence of extensive diaphyseal changes are both inconsistent with skeletal syphilis of the early weeks of life. Trauma and injury prior to the onset were not observed in any case and the recurrences in the hospital were certainly not associated with trauma. Neoplasia need

not be considered in view of the results of the biopsies and the benign clinical course.

Infection cannot be excluded so satisfactorily. The long febrile course in Case II and the febrile episodes in Cases I and III suggest that infection was the causal agent. The development of pleural disease in 3 patients and especially the cellular reaction of 500 monocytes per cubic millimeter in pleural exudate of Case I, the only case in which there was an opportunity to examine the pleural liquid, strongly suggest infection. Bacterial infection was not proved in any case—none of the swellings was suppurative, biopsies disclosed no evidence of inflammatory reactions in the affected bones, blood cultures and agglutination tests were negative, and smear and culture of the pleural exudate yielded no bacteria. We were unable to investigate virus infection adequately.

Rivers[8] has demonstrated that experimental virus infection of the cornea may be followed by a reaction that is exclusively hyperplastic without cellular infiltration. A similar hyperplastic reaction in the osteogenetic layer of the periosteum could conceivably be responsible for the cortical hyperplasia found in these bones. So far as we know, hyperplastic osteitis has not been recognized in human virus infections. Councilman and his colleagues[4] found focal necroses in the bone marrow of the vertebral bodies in smallpox but they do not mention cortical involvement. Virus infections during early infancy may be more common than is generally appreciated by clinicians, as indicated by the reports of Von Glahn and Pappenheimer,[10] Farber and Wolbach,[5] Kinney,[6] and Buddingh and Dodd.[2]

The exceedingly rapid development of the facial swellings in our patients resembles the sudden appearance of angioneurotic tumors. Pruritus was not associated and there was no concomitant eosinophilia. Subperiosteal allergic edema is a possible cause of the cortical thickenings; allergenic edema may also have been responsible for the swellings in the neighboring soft parts.

The data in this group of cases indicate that the clinical and roentgen manifestations represent a new syndrome. The cause is at present undetermined. The possibilities of virus infection or allergic reaction as the causal mechanisms deserve consideration in the investigation of future patients whose findings suggest that they are affected.

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VOL. 54, NO. 1

HYPERTROPHIC PYLORIC STENOSIS IN INFANTS

ROENTGENOLOGIC DIFFERENTIAL DIAGNOSIS*

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LITTLE has been written on the use of the roentgen ray in the diagnosis of hypertrophic pyloric stenosis in infants. This is probably due to the fact that in the past the roentgen department was not given the opportunity of making many gastrointestinal studies on infants in whom pyloric muscle hypertrophy was suspected clinically. Among the many reasons were:

1. A history of bile-free vomiting in an infant three to six weeks old with a palpable mass in the epigastrium to the right and above the umbilicus and visible abdominal waves corresponding to gastric peristaltic activity was considered sufficient clinical evidence to warrant a diagnosis of pyloric muscle hypertrophy with varying degrees of stenosis.

2. If symptoms persisted after a change of formula, and the administration of antispasmodics, surgery was indicated.

3. Many clinicians and surgeons not only believed that a roentgen examination was unnecessary but strongly objected to the use of barium for fear of aspiration and so forth.

4. The difficulty of removing barium by lavage leaves a residue which may interfere with operative procedures.

5. The request to withhold food for six hours or more during the roentgen examination interfered too greatly with the nutritive requirements of the infant.

In our experience it was usually the less severe cases, those in which the clinical findings were not clear cut, when there was no dehydration, no definite nutritional disturbances and the infant appeared healthy, that roentgen examination was resorted to, and then chiefly to estimate the rate of gastric motility. Occasionally, at the request of the pediatrician, a small amount of barium was added to the formula simply as a "tracer" medium to determine gastric emptying time. This usually confused the picture, as delayed motility was due to the presence of fat, and to a lesser degree protein and carbohydrate in the formula. Too short a time interval between the last feeding and the administrations of barium also resulted in delayed emptying time in the normal infant, yet, under these circumstances, a retarded gastric motility with prolonged emptying time was often accepted, in conjunction with symptoms and clinical findings, as sufficient evidence for operative intervention. A water-barium mixture should be given on an empty stomach, at least four hours after the last feeding.

There are numerous factors influencing the emptying time of the normal infant's stomach, and infants, healthy in every respect, often show small gastric residues at the end of ten, twelve, and even twenty-four hours. A common cause of delayed gastric motility is gaseous distention of the gastrointestinal tract. Infants are notoriously aerophagic, not only while feeding but also in the act of crying, yawning and stretching. Atmospheric air apparently enters the stomach with ease in deep inspiration when the esophagus is apparently put on a "stretch" and filled with atmospheric air. This is probably aided by the fact that the ratio of the height to the width of the chest in infants is much less than in normal children and adults. Whether relaxation or hypotonicity of the esophageal sphincter plays a part in the admittance of air into the stomach is indefinite. However, with the stomach and small intestine distended with gas and the infant allowed to remain in the supine posi-

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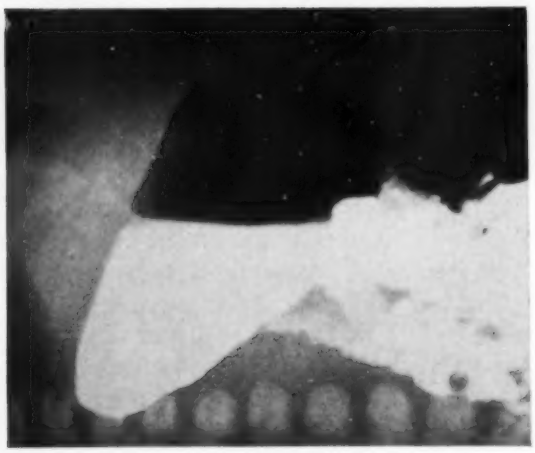

Fig. 1. Lateral recumbent view showing relationship of cardiac end of stomach to gas-distended antral end. In this position the emptying time may be prolonged two or three times that of normal.

tion, there is a definite tendency toward delayed gastric motility and prolonged emptying time, for so long as the patient is kept in the supine position, little of the gas can escape from the stomach through the esophagus.

Apparently only a negligibly small amount of swallowed air is absorbed from the intestine by the blood stream. That the gas in the stomach and small intestine is largely swallowed air can be demonstrated in an abdomen previously free of gas by observing its gradual accumulation during feeding or the act of crying, first in the stomach, then the upper small intestine, and gradually the lower portion of the small intestine and finally the cecocolon.

Under these conditions, we have encountered as high as 40 to 50 per cent gastric retention at the end of ten hours and 20 to 25 per cent at the end of twenty hours.

Repeating the examination several days later, after the elimination of most of the gas from the stomach and practically all of the gas from the small intestine (by placing the infant for several hours in the semirecumbent prone position with slight elevation of the right shoulder), we encountered normal gastric emptying time of two to two and a half hours.

The abdomen should be almost free of intestinal gas before water-barium is administered on an empty stomach. Under these circumstances, extraneous influences of gas are eliminated and a more accurate evaluation of gastric motility is thereby determined.

Apparently gaseous distention of the small intestine reflexly *inhibits* gastric peristaltic activity and delays motility. In the prone position most of the gas in the stomach and possibly a small amount in the upper small intestine is regurgitated through the esophagus while that remaining in the small intestine is propelled into the colon. If by this method, the small intestine cannot be rid of gas, an investigation of the tension of the anal sphincter should be made, for in sphincterismus ani, the colon remains distended and prohibits the caudad movement of gas in the small intestine.

In two instances of vomiting with delayed gastric motility, the vomiting ceased and there was a return to normal gastric motility following correction of an anal sphincter spasm.

This gaseous distention of the small intestine does not as a rule take place if, after feeding, the infant is immediately placed in the semirecumbent prone position where the gas is readily regurgitated through the esophageal opening which now occupies a position atop the gastric gas bubble.

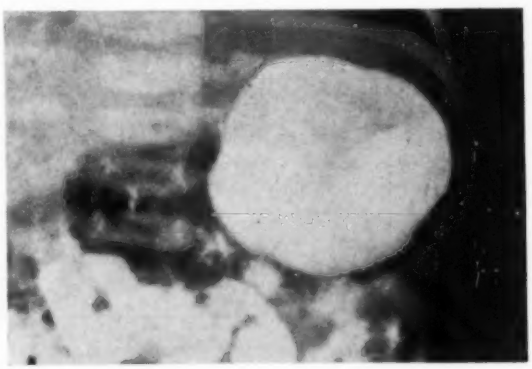

Fig. 2. Anteroposterior view (supine position) showing rounded appearance of barium in cardiac end and accumulation of gas in pyloric end. Neither the cap nor pyloric canal is visualized in this position.

In the supine position, however (Fig. 1), the swallowed air in the stomach rises above the esophageal opening and occupies the pars media and the pars pylorica at a level above the hiatus; thus it cannot be regurgitated through the esophagus, and the ingestion of any liquids merely forms a "pool" (Fig. 2) in the dependent cardiac portion of the stomach which literally "seals off" the cardiac orifice. Further ingestion of formula merely increases the gas pressure and gradually forces the swallowed air through the pyloric canal into the upper small intestine. At times, an additional accumulation of air in the high arched pyloric antrum seems to act as a "gas trap" and prohibits the egress of barium through the pyloric ring. These are the stomachs in which the barium appears as a round dense shadow in the upper left quadrant in the supine position, surrounded by a large tubular gas shadow tapering off to the right of the spine at a slightly lower level. When the stomach is greatly distended with gas, no peristaltic activity is encountered and there may be little or no motility over a period as long as twenty hours (Fig. 3).

Changing the infant from the supine to the prone position reverses the relationship of the gas and fluid contents of the stomach. The gas now accumulates in the high cardiac end of the stomach where it can readily be expelled through the esophageal opening and the barium comes to occupy the pars pylorica where, in the normal infant, normal gastric motility follows.

PROCEDURE

1. Two erect 8 by 10 inch roentgenograms are taken at 6 feet (posteroanterior and lateral at 1/20 second) within one-half hour of last feeding. These roentgenograms include the chest and abdomen. By using chest technique and including the lung fields, one can eliminate the presence of atelectasis or pneumonic consolidation, particularly the chronic type of pneumonias, as a cause of anorexia and vomiting, for the latter may run a normal temperature and not be suspected clinically. The retropharyngeal space and esophagus when filled with air are also visualized in the lateral view. Occasionally, bulging of the posterior pharynx due to cellulitis will interfere with the swallowing function and account for regurgitation.

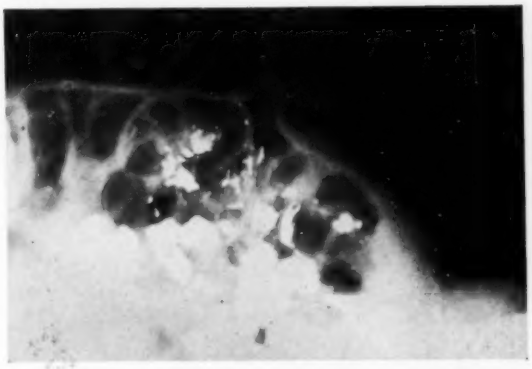

FIG. 3. Lateral view showing small umbilical hernia.

2. The amount of gas and fluid in the stomach and the distribution of gas in the small intestine are noted. Normally gas in the small intestine is evenly distributed throughout the jejunum and ileum. If the distribution of gas is largely limited to one side or one quadrant of the abdomen, it presupposes the possibility of some congenital malformation (Fig. 4) such as anomalous mesenteric attachments, nonrotation, various types of intra-abdominal hernias, congenital bands, and so forth.

A variable portion of proximal small intestine outlined by gas, sharply delimited in the upper abdomen but an absence of small intestinal gas in lower abdomen and pelvis strongly suggests the possibility of congenital bands. With congenital duodenohepatic bands, only the stomach and first and second portions of duodenum may be distended with gas, while in "Lane's kink" type the entire intestine, exclusive of the right lower quadrant may be distended, and in the various types of congenital intra-abdominal hernias, gas-filled loops are "bunched together" and segregated more or less in one part of the abdomen. In the absence of these types of congenital anoma-

lies, there is a segmented distribution of gas in the small intestine; thus it is advantageous to have gas in the stomach and small intestine for the initial survey roentgenogram in the erect position. Its total absence is strongly suggestive of atresia of the esophagus, although this is found in very early infancy and not in the period when pyloric hyperplasia is suspected.

Fig. 4. B. A., aged one month. Note collection of small intestinal gas in upper right quadrant. Postoperative diagnosis: anomalous mesenteric attachment of small intestine with many loops bunched together and volvulus. Patient died two weeks following operation.

3. The infant is now placed in the semirecumbent prone position for approximately three hours or longer in an attempt to get rid of all the gas in the small intestine and most of the stomach gas. This is important, for a gas-distended small intestine will have an effect similar to an "adynamic ileus" and greatly retard gastric motility; it may even be the cause of vomiting. So, along with the variability of the normal gastric emptying time and the cyclic propulsion of the barium through the pyloric ring, we have the additional influence of a gas-distended small intestine. The standard water-barium mixture is administered through an ordinary nipple and, roentgenoscopically, the esophagus and swallowing function are observed and the size, shape, position, tonus and quality of gastric peristalsis noted. The amount of the opaque medium administered corresponds to that of the formula for the age of the infant (2 ounces is usually sufficient). If there is any hindrance to the passage of barium through the pyloric canal, one usually encounters vigorous peristaltic action with deep waves passing along both curvatures. In the early stages it presents the picture of a "fighting stomach." These contraction waves are seen mostly in the pyloric antrum and middle third. Visualization of the duodenal cap depends upon the degree of patency of the pyloric canal: if the latter is markedly narrowed, or, in the presence of pylorospasm it is impossible to fill the cap and the latter is represented only by small specks of barium. In those cases with symptoms of relatively long standing, i.e., two weeks or longer of intermittent projectile vomiting, one will not encounter a tonic stomach of normal size with vigorous peristaltic waves, but a dilated, atonic type of stomach with little or no visible peristaltic action, and, when peristalsis is observed it is feeble and superficial in character. When this stage of myasthenia gastrica is reached, there is almost complete pyloric obstruction and in this stage of exhaustion the patient no longer vomits.

4. Antispasmodics are administered to the infant throughout the examination in an attempt to eliminate the factor of spasm. In spasm per se, there is a marked variability in length and width of the pyloric canal; it becomes markedly elongated in antral spasm. However, if a sufficient number of exposures is made at the right time, i.e., during and following a contraction wave, one can usually demonstrate a pyloric canal of variable length. At least one roentgenogram will show a canal of several millimeters in length (Fig. 5).

5. Roentgenograms are taken at one-half hour intervals in order to record the peri-

odic emptying of the stomach, for motility in infants is normally much more variable than in adults. Hence, if there is little or no motility during the first two or three "half-hour" periods, the fourth "half-hour" interval may show normal motility with good visualization of the duodenal cap. In the event of good visualization of the duodenal cap, the gastric motor function is considered to be within normal limits even though the emptying time may be prolonged to four to six hours or more. Pylorospasm may show very little motility

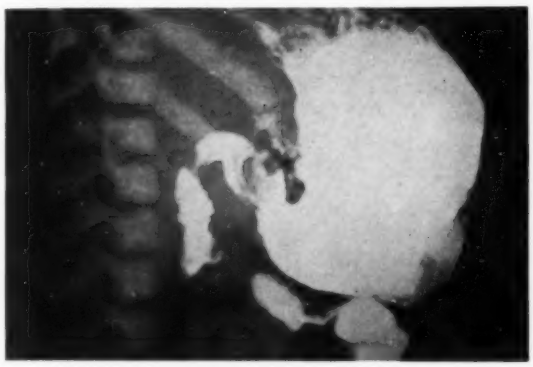

FIG. 5. Normal cap and pyloric canal showing antral contraction. The pars media "tapers" gradually and merges imperceptibly with the pyloric canal.

during the first hour, while the second hour may show emptying of the major portion of barium from the stomach. Three hours is considered long enough time in which to get a record of at least one cycle of activity in order to estimate the rate of motility and the anatomical status of the pyloric canal. In the intervals between examinations, the infant is kept in a semirecumbent prone position.

As soon as gastric peristalsis is encountered, serial roentgenograms may demonstrate the pyloric canal and its variability, if any, in length.

In pyloric muscle hypertrophy, there is no variability in the length of that prepyloric segment and no cycles of gastric motility. There may be an apparent variation in the length and diameter of the pyloric canal as a whole, but there is one prepyloric

FIG. 6. B. A., male, aged five weeks. Projectile vomiting one week. Hypertrophic pyloric stenosis. Note narrow elongated and relatively straight pyloric canal measuring 2.5 cm. in length, not influenced by antispasmodics. The barium stops abruptly along proximal border of tumefaction which is convex towards lumen of stomach with the formation of "shoulders." Operation—pyloromyotomy (Fredet-Rammstedt type) with complete relief of symptoms.

segment that is constant and unchanging in length and caliber of lumen. This segment is longer and the lumen narrower than what we believe to be the normal length and width of the pyloric canal in infants. Under these circumstances we have re-

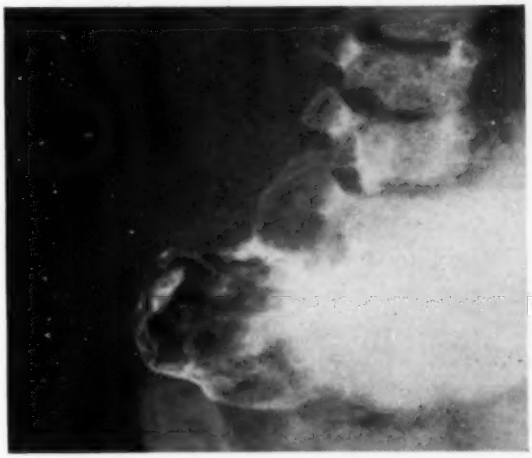

FIG. 7. E. F., female, aged six weeks. Projectile vomiting one week. Waves were observed across abdomen but no masses palpable. The pyloric canal is curved and markedly elongated—3 cm. Duodenal curve normal. Note the "shoulder appearance" on either side of pyloric canal. Operation—pyloromyotomy (Fredet-Rammstedt type). Symptoms relieved.

examined a limited number of patients with and without antispasmodics and found no alteration in that portion of the prepyloric canal elongated and narrowed by local pyloric muscle hypertrophy or change in the ultimate emptying time of the stomach. On the other hand, gastric motility in pure

Fig. 8. M. S., female, aged nine weeks. Vomiting after feeding—past week. Note linear pressure defect running across pyloric antrum. Operation—congenital gastrohepatic band.

pylorospasm is influenced by time and antispasmodics. The latter largely eliminate the initial retarded motility encountered in the first and second half-hour intervals and the ultimate emptying time may be brought to within almost normal limits.

In pyloric muscle hypertrophy (Fig. 6 and 7), the amount ejected from the pyloric canal depends upon the degree of narrowing, but there is a rather regular and constant ejection of barium into the duodenum from the time barium is introduced into the stomach until it is nearly empty. The last 25 per cent may require more time for evacuation than the initial 75 per cent—this may be due to a gradual subsidence of the vigorous, intermittent peristaltic waves observed at the beginning of the examination. One must remember, however, that in a normal stomach the rate of motility decreases as the stomach empties, and it is not uncommon to find traces of barium in the normal infant's stomach ten to twenty hours following the barium meal.

When congenital bands run across the pyloric end of the stomach and exert sufficient pressure to interfere with gastric motility, we likewise encounter hyperperistalsis. Here, however, when the stomach antrum is in a state of diastole and filled with barium, a sharp line of demarcation running from the lesser to the greater curvature can often be demonstrated in the form of an extrinsic linear pressure defect seen in the posteroanterior recumbent, or lateral erect roentgenogram (Fig. 8). This defect may be produced by a gastrohepatic or gastrocolic band or persistent mesogastrium. The pyloric canal may show a marked variability in its length and caliber. Here, as in localized pyloric muscle hypertrophy, the duodenal cap may never be completely filled, but there is complete absence of a persistent narrowed and elongated prepyloric segment.

A congenital peritoneal fold impinging on the lumen of the small intestine will show stasis and possibly some dilatation proximal to the points of obstruction; when it involves the duodenal loop proximal to the ampulla, the vomitus is not bile stained. The size of the cap and degree of dilatation of the duodenum will depend, to a certain

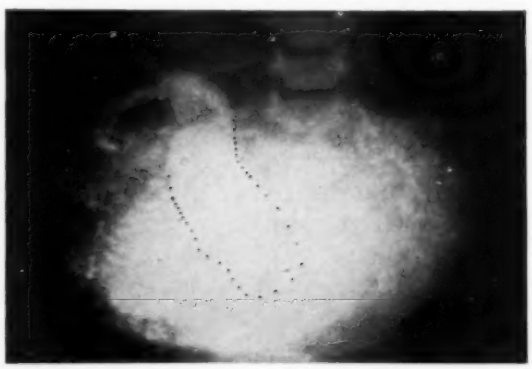

Fig. 9. A. C., female, aged one month. Note the elongated pyloric canal, stasis and dilatation of the duodenum with reversal of its curve and abrupt ending of barium near duodenojenunal junction. Operation—(1) congenital hypertrophic pyloric stenosis and (2) anomalous mesenteric attachment with volvulus of small intestine just proximal to ligament of Treitz. (Second and third portion of dilated duodenum outlined as seen on original roentgenogram.)

extent, upon the duration and degree of obstruction. There may be stasis, but very little dilatation of the intestine in mild stenosis and recurrent volvulus due to abnormal peritoneal folds or volvulus associated with non-rotation of the colon.

Intrinsic obstruction is more common than extrinsic in the newborn. In atresias, the newborn begins vomiting soon after birth. Vomiting is persistent and bile stained. The stomach and entire small intestine proximal to the point of obstruction are distended even at birth by accumulation of digestive juices and swallowed amniotic fluid. An erect roentgenogram soon after vomiting may show a large gas-distended stomach and small intestine proximal to the point of obstruction; the rest of the small intestine is non-air containing. This finding, plus the clinical history, is sufficient evidence to warrant a diagnosis of small intestinal obstruction and the administration of barium may yield no further information, although it may be possible to completely fill the duodenal cap—a finding not encountered in pyloric stenosis. Volvulus may produce a somewhat similar picture, but here the obstruction may be intermittent and small amounts of gas or barium may outline the small intestine distal to the point of obstruction and examination during an asymptomatic period may reveal nothing abnormal. These patients should be examined immediately after an episode of vomiting. Gastric hyperperistalsis was never encountered in either complete or incomplete obstruction distal to the pyloric ring. In hypertrophic pyloric stenosis, vomiting usually occurs for the first time during the third to fifth week of life with a gradual increase in the severity of symptoms and prior to this time there may have been no feeding problem. During the first few days of vomiting, the stomach is orthotonic and normal in size; later it enlarges and becomes atonic. We have not encountered complete obstruction in any case of pyloric muscle hypertrophy and once the barium enters the small intestine it proceeds normally to the cecum, showing a variegated and segmented pattern of the small intestine. Well filled continuous loops are not encountered in retarded gastric motility.

In order to appreciate the roentgen appearance of pyloric muscle hypertrophy, a brief description of the gross anatomic findings may be helpful.

The pylorus presents a fusiform, olive-sized hyperplasia, presumably of congenital origin, involving the circular muscle fibers of the pyloric canal. It terminates abruptly at the pyloric ring; the caliber of the lumen is decreased, its external surface smooth and almost as firm as cartilage. Origin on an endocrine basis is a possibility, as it occurs in males at a ratio of 3 to 1 and in some series as high as 10 to 1. It has been reported in male twins. That reflex pylorospasm should produce a tumor mass of this size and character within a period of three weeks is rather unlikely. Spasmophilia as a factor must be considered.

On serial roentgenograms, the elongated and narrow caliber of the pyloric canal can usually be demonstrated. It ranges in length from 0.5 cm. to 3 cm. In severe cases, the canal may be represented by a mere thread of barium which is constant and uniform, while in others there is very little diminution in caliber, although there may be marked elongation. The caliber is persistent and unchanging in configuration and not influenced by antispasmodic drugs. The canal may appear to change in length but this is due merely to superimposed antral contractions. The tumor stops abruptly at the base of the duodenal cap. At the antral end it may merge gradually with the stomach wall, but more often it is seen to project convexly into the lumen of the stomach, forming "shoulders" about the proximal aperture of the canal. If only a segment of the canal is visualized, it appears as a small "beak-like" process of barium, its base resting on the "shoulders" in the midline and its point directed toward the cap. We were unable to demonstrate any depressions, crevices, or suggestions of mucosal folds in the canal or deep trans-

verse sulci or gastric mucosa at the proximal portion of the tumefaction. Neither was there any evidence of a concavity at the base of the duodenal bulb as a result of a partial invagination of the hypertrophied muscle, described by Kirklin[1] as occurring in pyloric muscle hypertrophy of adults.

The normal pyloric canal as seen on serial roentgenograms, varies in length and caliber according to the degree of pyloric and antral contraction. That short segment of pyloric canal adjacent to the base of the bulb, which is constant in length and caliber in diastole, represents the pyloric ring. This measures, on an average, 2 mm. in diameter and a variable 2 to 4 mm. in length on roentgenograms taken at a 36 inch distance. The greater and lesser curvature merge gradually toward the base of the duodenal cap. In the absence of any gastric or small intestinal gas, the normal infant's stomach will evacuate the major portion of the barium meal, i.e., 75 to 85 per cent, in two and a half hours when in the prone position. This was considered as a normal rate of gastric motility during one of its periodic cycles of evacuation. Realizing the difficulty in ascertaining a true estimate of the amount evacuated during any one time period, a fair estimate of the rate of motility was based on the ease with which the cap filled and to a lesser degree the pattern of the upper small intestine. With rapid gastric motility, there is either a continuity of or a closer approximation of the segments of barium in the small intestine.

In those cases in which congenital lesions occur distal to the pyloric ring, involving the small intestine, such as congenital atresias or stenosis, duodenohepatic bands, Lane's kink, anomalous mesenteric attachments of the small intestine with recurrent volvulus, intra-abdominal hernias of various kinds, etc., the stomach appears atonic, slightly dilated with shallow, superficial gastric peristaltic waves occurring at lengthy intervals; gastric hyperperistalsis is seldom encountered. The pyloric canal is within normal limits and the duodenal cap can usually be completely filled. The barium is not ejected into the duodenum with any degree of regularity as in hypertrophic pyloric stenosis, but is ejected spasmodically at extremely long intervals. The cap fills readily and completely on manual pressure and may remain filled for several minutes to several hours. In addition to the cap, the small intestine proximal to the point of obstruction is very often outlined by barium.

In the absence of any demonstrable extrinsic gastric pressure defect, it may be extremely difficult, from a purely objective standpoint, to differentiate a congenital extragastric anomaly such as a gastrohepatic band or persistent anterior mesogastrium from hypertrophic pyloric stenosis. In both instances, there will be incomplete filling or non-visualization of the duodenal cap. Intermittent hyperperistalsis may be encountered. However, the pyloric canal, if visualized, will appear normal in length and caliber. There is an absence of "shoulders" projecting into the antrum and also the "beak-like" projection toward the cap. The history will aid in arriving at the correct diagnosis, for with congenital bands, there may have been a feeding problem from the time of birth or shortly thereafter with a gradual increase in symptoms of vomiting as the infant grows, reaching a climax at the fourth to sixth week or even as late as three months and on rare occasion as late as ten months. This gradual and progressive increase in the severity of the symptoms is due to the fact that as the infant grows the fibrous bands remain practically stationary and thus exert a relatively greater pressure defect.

During the past two and a half years (January, 1940, to July, 1942), we studied the gastrointestinal tract of 50 infants according to the technique outlined. The severity of symptoms varied from that of projectile vomiting during or following each meal to that of occasional vomiting during or following a feeding. The age at the time of examination ranged from thirteen days to nine weeks—average, 6.3 weeks. The examination was usually started on the fourth

or fifth day of symptoms. There were 18 females and 32 males, a ratio of 1 to 1.8. The majority were sent for roentgen examination with a tentative clinical diagnosis of hypertrophic pyloric stenosis. In the remainder, a request was made to determine cause for continued intermittent vomiting after failure to completely control vomiting by antispasmodics and thick feedings.

In 12 infants, periodic vomiting was not influenced by thick gruel feedings and antispasmodics. They lost weight, became partially dehydrated and operative intervention, after adequate preoperative treatment, was decided upon. From a roentgenologic standpoint, all except 2 showed elongation of the pyloric canal with a diminution in caliber. The narrowing in some instances was such that the canal was represented simply by a "thread of barium," its length measuring 1.0 to 2.5 cm. or 3.0 cm. There was no cycle of normal motility, but rather almost constant ejection of small amounts of barium with each contraction wave during the first three or four hours, with an eventual prolonged emptying time of twelve to twenty-four hours. There was a direct relation between the degree of narrowing and elongation of the canal and the rate of gastric motility. In those cases with marked narrowing, as much as 80 to 90 per cent retention was encountered at the end of four hours and as high as 50 per cent at the end of twenty-four hours.

The duodenal cap was never completely filled in a single instance of uncomplicated hypertrophic pyloric stenosis. In most instances, it was visualized only by a few specks of barium and, due to the tremendously slow rate of motility, the small intestinal pattern appeared "thready," connecting sparsely scattered small clumps of barium.

One case with good visualization, complete filling of the cap, and a normal pyloric canal had a congenital duodenohepatic band completely obstructing the duodenum just above the ampulla of Vater (Fig. 10). This patient had bile-free vomitus.

Fig. 10. B. G., female, aged thirteen days. Intermittent vomiting since birth with gradual increase in severity of symptoms. Vomitus not bile stained. Stomach normal, cap filled readily, peristalsis shallow. No barium left the stomach during the first six hours. There was approximately 80 per cent gastric retention at the end of twenty-four hours. Operation—congenital duodenohepatic band running across second portion of duodenum just above ampulla.

Another case with poor visualization and incomplete filling of the cap had a normal pyloric canal but showed an extrinsic pressure defect running across the pyloric antrum, which at operation proved to be due to a congenital gastrohepatic band.

Operative Findings

Hypertrophic pyloric stenosis (8 males and 1 female)	9
Hypertrophic pyloric stenosis and volvulus of small gut (F)	1
Congenital duodenohepatic band (F)	1
Congenital gastrohepatic band (F)	1
Total	12

Fig. 11 and 12. S. D., male, aged four days. Regurgitation of formula with each feeding since birth—occasional vomiting. Note dilated air-filled esophagus, gas-distended cardiac end of stomach with fluid level.

In the group with marked pyloric obstruction, examinations made within several days of the onset of symptoms usually showed stomachs of the orthotonic type with intermittent hyperperistalsis. If symptoms persisted more than a week prior to the examination, the stomach was as a rule hypotonic and occasionally dilated and atonic; peristalsis was shallow, occurred at lengthy intervals, or was not encountered at all. At this "advanced stage," vomiting is not as severe and occurs less frequently than in the earlier stages—probably due to marked atonicity and refusal of formula by the infant which, as a rule, vomits only when part of a formula is introduced into a stomach already the seat of marked retention.

In the second group of 20 cases, the severity of the vomiting seemed to be far out of proportion to the degree of pyloric narrowing and elongation. There was vomiting either during or after practically every feeding of a formula of ordinary consistency, not influenced by antispasmodics, although controlled to a variable degree by thick feedings. On the roentgenogram, there was very slight, if any, narrowing of the pyloric canal, which did not exceed a length of 0.5 cm. They showed intermittent hyperperistalsis with an occasional reverse peristaltic wave resulting in regurgitation of the barium. The stomachs, as a rule, were orthotonic, there was not a marked degree of retarded gastric motility, and the cap was fairly well visualized. It was thought that these infants represented mild cases of pyloric muscle hypertrophy and that vomiting was due largely to a disturbed gastric motor function. The amount of gastric retention at the end of four hours ranged from 40 to 50 per cent. All of these cases were sufficiently controlled by expectant treatment so that neither dehydration nor nutritional disturbances ensued and symptoms gradually disappeared.

The third group, consisting of 18 cases, had mild episodes of vomiting, occurring at irregular intervals, but usually at the completion of a feeding. One had intermittent regurgitation during each feeding. This infant was later shown to have a megaesophagus (Fig. 11 and 12). Survey roentgenograms showed a marked gaseous distention of the stomach and small intestine, and roentgenoscopically one could demonstrate large gulps of air in the esophagus with resultant distention of the stomach.

Peristalsis was shallow, gastric motility retarded, but, as far as we could determine, the pyloric canal was within normal limits. As a rule, very little barium left the stomach during the first hour and at the end of two and a half hours there was approximately 50 to 60 per cent retention; at the end of four hours there was approximately 25 per cent retention. The stomach and small intestine showed abnormally large amounts of gas during the entire examination. Inadvertently, these patients had not been placed in the prone position either before or during the examination. All were re-examined one or two weeks later, and it was made certain that they were kept in a prone position both before and during the examination. This resulted in a marked reduction in the amount of gas in the stomach and almost complete elimination of gas from the small intestine. Under these conditions, normal motility followed with at least 80 to 90 per cent gastric evacuation at the end of two and a half hours.

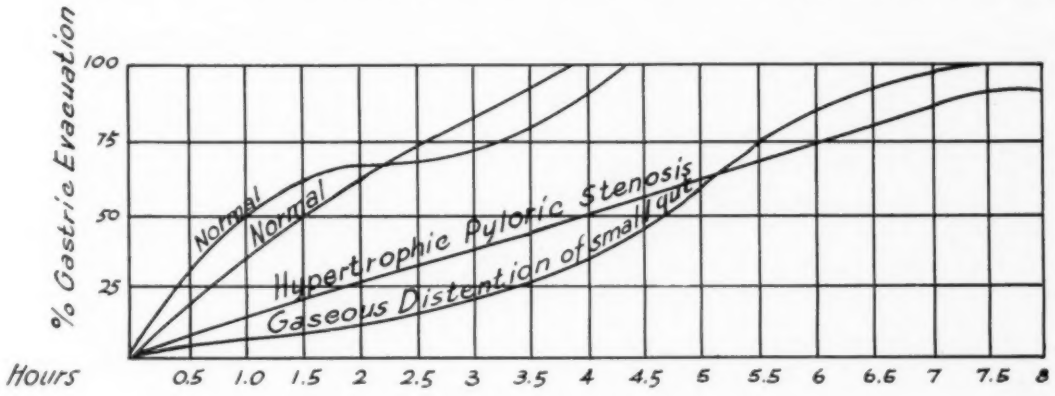

Chart I. Gastric motility rate normal; hypertrophic pyloric stenosis and gas-distended small intestine.

However, in 2 cases, while the stomach was relatively free of gas, large amounts of gas still remained in the small intestine and the colon; the latter was markedly distended. Again we encountered delayed gastric motility with 50 per cent gastric retention at the end of four hours in 1 case and, in the other, approximately 90 per cent at the end of eight hours and at least 50 per cent at the end of twenty-four hours. Due to distention of the colon, the anal sphincter was investigated and found spastic. Stretching of the anal sphincter was begun. Two weeks later, a survey roentgenogram showed no gas in the small intestine and only a moderate amount in the colon after a period of four hours in the prone position. Re-examination with barium revealed normal gastric motility and emptying time, i.e., at least 75 to 80 per cent of the barium was evacuated at the end of two and a half hours. These 2 cases probably demonstrate the existence of a gastric inhibitory reflex of ileocolic origin, which disappeared following correction of anal sphincter spasm.

When the infant's stomach is orthotonic, the small intestine free of gas, no distention of the colon, and the motility rate is sufficient to completely fill the cap, we have accepted two and a half hours as the normal emptying time of the major portion of barium from the infant's stomach, i.e., 75 to 85 per cent. The final and complete emptying of the normal infant's stomach is so variable that it is of little or no diagnostic importance, for not infrequently traces are found ten to twelve hours or longer after ingestion. These cycles of gastric motility are apparently brought about by extraneous conditions, so that evaluation of the emptying time, without consideration of the "motility cycle," is misleading. On numerous occasions, motility did not really begin until the second or third hour

or later; then it proceeded normally—hence, we may have a four to six or eight hour emptying time in a perfectly normal stomach. Gaseous distention of the colon with an incompetent ileocecal valve may produce an intermittent ileus with corresponding reflex gastric inactivity and absent motility for several hours. Under these circumstances, a saline enema or simple deflation of the colon will almost immediately bring about normal gastric motor function and motility.

In our proved cases of advanced pyloric stenosis, the more rapid motility rate took place during the first three or four hours, followed by a much slower rate or complete gastric inactivity—requiring ten to twelve or more hours for complete evacuation.

The cases (20) interpreted as mild pyloric muscle hypertrophy had a pyloric canal not exceeding 0.5 cm. in length and an emptying time of four to four and a half hours. The cap was visualized fairly well in all these cases, and, in approximately one-half this number, gastric peristalsis was hyperactive, with the observance of an occasional reverse gastric peristaltic wave. In the remaining half, the stomach was atonic, enlarged, with never complete filling of the cap. These patients all did well with antispasmodics and thick gruel feedings; all were symptom free six months after initial examination. In all probability, the symptoms of vomiting were due largely to a disturbed gastric motor function. This group might include a large number of these cases in which subsidence of symptoms is ascribed to a gradual disappearance of the pyloric muscle hypertrophy. It is extremely doubtful whether true pyloric muscle hypertrophy with symptoms not controlled by thick gruel feedings and antispasmodics ever disappear spontaneously. While one may not be justified in making a diagnosis of moderate pyloric muscle hypertrophy based on the length of the pyloric canal, retarded gastric motility is certainly not a reliable index due to the numerous extragastric influences on the rate of gastric evacuation, and in this particular group regurgitation was frequently associated with reversed gastric peristalsis seen roentgenoscopically.

With complete, incomplete, or recurrent obstruction distal to the pyloric ring, the stomachs were usually large, atonic, with shallow peristaltic waves, if any, and a dilated intestine proximal to the point of obstruction. There was no period of normal gastric motility, and the amount of gastric retention was, in general, proportional to the degree of stenosis.

FINDINGS IN PYLORIC MUSCLE HYPERTROPHY

1. Early—a. Stomach orthotonic occasionally hypertonic. b. Intermittent gastric hyperperistalsis.
2. Late—a. Hypotonic to atonic. b. Feeble, shallow peristaltic waves limited almost entirely to the pyloric region.
3. A constant, unchanging, narrowed caliber of pyloric canal with elongation beyond 0.5 cm.
4. If pyloric canal cannot be demonstrated, one should look for a "beak-like" projection of barium pointing toward the cap from mid-portion of antrum.
5. The demonstration of "shoulders" convexly directed toward the pars media in well advanced cases.
6. Visualization of the cap simply by specks of barium or partial filling (never complete filling of cap).
7. Absence of cyclic motility and prolonged emptying time (50 per cent or less evacuated at the end of four hours, not influenced by antispasmodics.)

OBSTRUCTIONS DISTAL TO PYLORIC RING

1. Atonic and usually enlarged stomach.
2. Absence of peristaltic activity.
3. Normal pyloric canal.
4. Complete filling and good visualization of cap.
5. Stasis and dilatation of small intestine proximal to point of obstruction and collapsed intestine distal to this point.

6. Distended loop of small intestine limited to one part of the abdomen in the erect position.

CONCLUSION

In the absence of intracranial injury or pulmonary infection it is our belief that the roentgen examination has a definite place in the investigation of the infant's gastrointestinal tract in the presence of vomiting with clinical findings suggestive of pyloric stenosis. We can demonstrate the degree of pyloric stenosis or locate with a reasonable degree of accuracy the point of atresia or extrinsic pressure distal to the pyloric ring and thus guide the surgeon in his operative approach. The vast majority of these cases do not call for any emergency operative intervention and, if carefully studied, we believe one can largely separate the medical from surgical cases. One must keep in mind the cyclic activity and motility of the infant's stomach and its susceptibility to various extraneous influences and not rely solely on the rate of gastric motility as a very important criterion in pyloric stenosis. Of the 38 cases not operated upon, the symptoms in 18 were apparently due to an adynamic "ileus-like" state of the small intestine, largely the result of aerophagia. They respond readily to treatment directed to the elimination and prohibition of gas accumulation in the stomach and small intestine.

The 20 cases in which there might have been a moderate hypertrophy of pyloric muscle, with the canal not elongated beyond 0.5 cm., the symptoms were due largely to a disturbed gastric motor function, easily controlled by thick gruel feedings when extraneous influences are eliminated. These non-operative cases might include a large number in which the subsidence of symptoms has been attributed to a gradual disappearance of the hypertrophied mass of pyloric muscle. All were symptom free two to six months following the examination.

Those cases which will most likely require surgery have an enlarged, slightly atonic stomach, a narrow pyloric canal, elongated beyond 0.5 cm. and more than 50 per cent gastric retention under ideal conditions (usually 70 to 80 per cent) at the end of four hours.

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GASTRIC VOLVULUS AND OTHER ABNORMAL ROTATIONS OF THE STOMACH

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GASTRIC volvulus is an abnormal rotation of the stomach. Schatzki and Simeone[3] point out that any changes in position of the stomach must be by some form of rotation and, therefore, rotation, *per se*, is not necessarily volvulus, as in the case of high lying stomachs of obese individuals. They class the "upside down" appearance of the high stomach commonly found associated with eventration of the diaphragm as one example of the same phenomenon. However, true volvulus may occur in the presence of eventration (see Case VI). A rotation of the stomach, reaching or closely approaching 180 degrees, which spontaneously reduces itself, is reducible by manipulation, or can reasonably be assumed to be the result of injury, will be considered true gastric volvulus. Other abnormal rotations are those which are not subject to reduction either spontaneously or manually, and which can be assumed to be variations on a basis of congenital anomalies.

The terminology of classification of this unusual condition is conflicting. Singleton[5] states that "Gastric volvulus may be defined as an abnormal anterior or posterior rotation of almost all of the stomach about either the coronal or sagittal axis of the body. The stomach being fixed by the gastro-phrenic ligaments above and the peritoneum covering the second portion of the duodenum below, is limited in mobility between these fixed points only by the length of the gastro-hepatic omentum and may be displaced within these limits by extrinsic pressure from whatever cause. Pressure displacement of the stomach is, therefore, very common, but actual rotation of a part or almost all of the stomach is relatively rare and would seem to require unusually long gastro-hepatic and gastro-colic mesenteries to allow of its occurrence." He classes volvulus as to type: "(a) Organo-axial. Rotation of the stomach upward around the long axis of the stomach, i.e. around the coronal plane. (b) Mesentero-axial. Rotation of the stomach from right to left, or left to right, about the long axis of the gastro-hepatic omentum." Volvulus, according to Becker,[1] as reported by Morrison,[2] is an organo-axial rotation of the stomach, and torsion is a twist of the stomach. Torsion falls into Singleton's classification as mesentero-axial volvulus. Shanks, Kerley and Twining[4] state that in one type of volvulus, "the stomach folds itself on the coronal axis," and in the other type there is torsion of the fundus. For the purposes of this paper, volvulus will be divided into (1) organo-axial volvulus (rotation on the coronal axis) and (2) torsion volvulus.

In acute gastric volvulus, the rotation is so great that the blood supply of the stomach is interfered with, and immediate surgery is indicated. None of the cases presented here fall into this group.

The following cases, because of the characteristic roentgen findings and interesting clinical pictures, are believed worth reporting.

REPORT OF CASES

CASE I. (Case of Dr. V. W. Archer.) C.D.N., white, female, aged twenty-eight. The patient had previously been seen with varied complaints believed to be on a psychoneurotic basis. Her chief complaint was indigestion and burning in the epigastric and substernal regions. She was quite obese, her weight was 244 pounds, height 5 ft. 5 in. Although she was a nullipara there were striae over her abdomen. Hemoglobin was 85 per cent (Dare) but the

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feces and vomitus gave a four plus reaction to the benzidine test. Roentgenoscopic examinations showed the antrum twisted in relation to the body of the stomach. As a result of the torsion, the duodenal bulb pointed to the left (Fig. 1). With a few days of bed rest the symptoms subsided. Two weeks following this episode the stomach was negative. Four months later the stomach presented a cascade appearance which did not resemble either type of volvulus and was otherwise negative. There were no similar episodes over the period of one year following the first examination, during which time the patient had been on a reducing diet and had lost a good deal of weight.

Comment. The excessive degree of twisting, as demonstrated by the pattern of the rugal folds and the position of the bulb (Fig. 1) and the spontaneous reduction are consistent with the diagnosis of torsion volvulus.

In obese individuals a somewhat similar appearance is sometimes demonstrated in normal high lying stomachs. The minor twisting of the rugal pattern and the normal position of the bulb differentiate torsion volvulus from a normal high lying stomach.

Attention has been called to the difference in appearance between gastric volvulus and a cascade stomach. Intra-abdominal pressure due to obesity is believed a contributory factor in this case.

Fig. 1. Case I. Torsion volvulus. The twisting of the stomach on itself, demonstrated by the pattern of the rugal folds, occurs at the junction of the antrum and the pars media. The bulb is pointed to the left.

Fig. 2. Case II. Organo-axial volvulus. The rotation of the greater curvature into a superior position causes a relative shortening of the stomach and a pull on the bulb, causing the antrum and the bulb to point downward.

Case II. (From the files of University Hospital, Charlottesville, Virginia.) M.B.F., white, female, aged forty-two. For three years, at intervals of from one to three months, there had been attacks of nausea, vomiting and epigastric pain but no belching or hematemesis. Each episode was sudden and there were no premonitory symptoms. Symptoms were severe but undulating in nature, being first severe than gradually fading, this sequence being repeated several times in each attack. At no time during an attack did the pain disappear completely. The pain was localized in the epigastrium just below the xiphoid and did not radiate. It felt "as if something was squeezing down deep inside." In the months just previous to admission, attacks gradually became more severe, more frequent, and lasted as long as ten days. It is worthy of note that during these symptomatic periods vomiting occurred after solid food intake but not after intake of fluid alone. Appetite

was excellent except during a severe episode.

Two and one-half years prior to this admission, roentgen studies of the stomach had been negative. On this admission the diaphragm appeared normal on roentgenoscopic examination. In the upright position, barium flowed through the cardiac orifice into a large posterior gastric pouch. The pars media was rotated upward so that the greater curvature was above the lesser and it was superior to the level of the cardia. After this pouch filled the barium

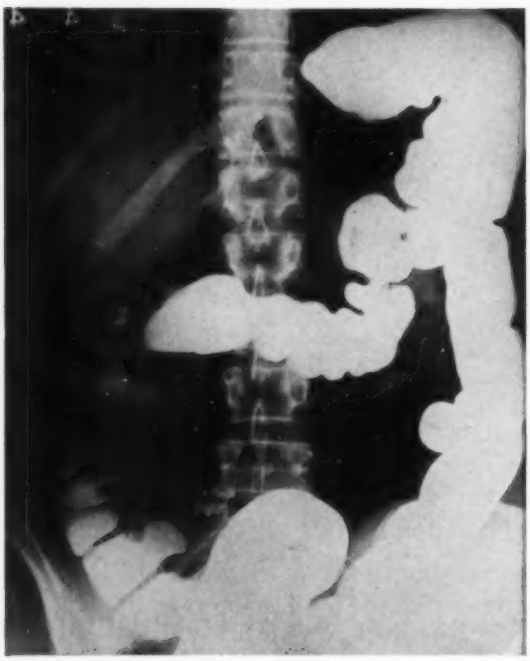

Fig. 3. Case II. Organo-axial volvulus. Barium enema showing the displacement of the splenic flexure upward and to the right due to the pull on the gastrocolic ligament by the rotated stomach.

poured into the rest of the stomach so that there were two fluid levels. The rotation of the greater curvature to a superior position in relation to the lesser caused a pull upward on the antrum and bulb which pointed downward. The roentgenogram in the prone position confirmed the rotation (Fig. 2). A barium enema demonstrated a pulling, cephalad and to the right, of the splenic flexure of the large bowel (Fig. 3). An exploratory laparotomy was performed and no abnormality of the stomach was found. Six weeks later a gastrointestinal series was entirely negative. Within the next year there had been five episodes similar to the previous attacks.

Comment. This case is believed to represent a typical picture of recurrent, chronic gastric volvulus, with the history typical as well as the roentgen findings. It is notable that the patient did not belch during attacks and it is thought that this was due to the dependent position of the junction of the cardiac orifice which prevented the stomach bubble from coming in contact with the cardiac end of the esophagus. Relaxed intra-abdominal ligaments are believed to be a contributory factor in the production of the abnormal rotation of the stomach in this patient.

Case III. (From the files of the University Hospital, Charlottesville, Virginia.) H.R.W., white, male, aged forty-two. This patient was admitted because of nausea, vomiting, epigastric discomfort, and progressive weakness of five months' duration. There had been a weight loss of 56 pounds. The clinical picture was clouded since there had been a recurrent diarrhea, nausea, and vomiting with fever three years previously, which was diagnosed as nontropical sprue. At the initial examination the diaphragm was normal. No abnormalities of the stomach were noted. The duodenum, from the bulb to the ligament of Treitz, was somewhat dilated and there was a low grade obstruction at this point. Reverse peristalsis alternated with normal peristalsis from the bulb to the ligament of Treitz in the upright, supine, and prone positions. There was tenderness at the point of obstruction. At six hours it was decided to re-examine the stomach and duodenum. On administration of additional barium, in the upright position, the meal was seen to enter a pocket at the cardiac end of the stomach. When this pocket filled the barium flowed up under the diaphragm and to the right, to form a loop as it flowed into the antrum which was drawn upward by a rotation of the stomach, causing the bulb and antrum to point downward. There was no delay at the ligament of Treitz at this examination. A barium enema showed a markedly redundant and dilated large bowel throughout. Otherwise, no abnormalities were noted in the large bowel. Four days later roentgen examination no longer showed the volvulus and again showed the delay at the ligament of Treitz.

Comment. This case of chronic gastric

volvulus demonstrated the "loop" effect sometimes seen when the barium first reaches the stomach. This effect is best seen with the patient upright, in the posteroanterior position before the fluoroscopic screen. The severe primary weight loss and the atonic redundant colon are believed contributory factors in the production of volvulus in this case. Shanks, Kerley, and Twining call attention to the unusual evanescent quality of gastric deformities due to the colon.

Case iv. (From the files of Holston Valley Community Hospital, Kingsport, Tennessee.) H. L., white, male, aged fifty-four. The patient was well until six months previous to examination, at which time he began to have constant nausea with discomfort in the epigastrium and para-umbilical area. He vomited several times. There was no hematemesis. Belching gave some relief. After this episode, which cleared up spontaneously, the patient was well until one month prior to examination, when he again developed nausea and vomiting. There was rapid weight loss and the patient became cachetic in appearance. His abdomen was almost constantly distended.

On roentgen examination the diaphragm was normal. The barium meal flowed into the stomach and was seen to make a loop in the cardiac portion. The greater curvature was rotated superiorly and the bulb and antrum were drawn upward; the pull of the gastrohepatic ligament caused them to point downward (Fig. 4). Except for this organo-axial rotation, no abnormalities were noted in the stomach. A large collection of gas in the colon, especially in the splenic flexure, was noted. A barium enema, which required twice the usual amount of barium mixture, showed a tremendous, redundant colon (Fig. 5). A re-examination of the stomach, following enemas, showed the stomach no longer rotated.

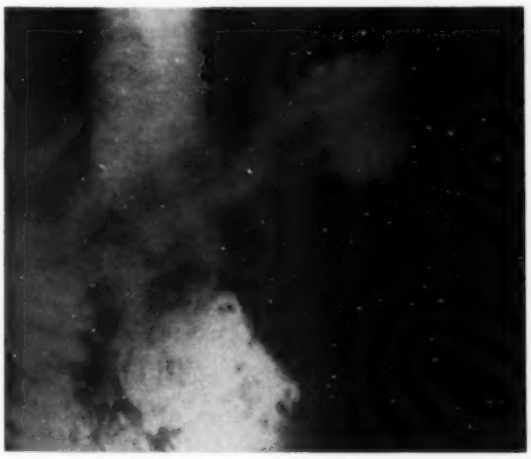

Fig. 4. Case iv. Organo-axial volvulus. The loop at the cardiac end of the stomach is demonstrated. The greater curvature of the stomach lies in a superior position. The antrum is pulled upward and the bulb points downward.

Fig. 5. Case iv. Organo-axial volvulus. An air contrast study of the large bowel showing the unusual degree of redundancy.

Comment. This case of chronic organo-axial volvulus is associated with a very redundant colon. The transient quality of this type of abnormal rotation, associated with abnormalities of the large bowel, was again demonstrated.

Case v. (From the files of University Hospital, Charlottesville, Virginia.) B.E.L., white, male, aged sixty-one. The patient was admitted following a four day history of nausea and repeated vomiting, but no hematemesis or tarry stools, associated with burning, cramping

Fig. 6. Case v. Organo-axial rotation of the stomach. High mid-transverse colon, in anterior hepatodiaphragmatic interposition, associated with the organo-axial rotation of the stomach.

epigastric pain. Although the pain was chiefly epigastric, it had occurred in both flanks and both upper quadrants and on one occasion had radiated to the shoulders. Until this episode there had been no gastric symptoms for over twenty years.

Roentgen examination showed a normal diaphragm. The stomach was rotated so that the greater curvature lay in a superior position, the antrum and bulb pointed downward. A barium enema showed the mid-transverse colon displaced upward in partial hepatodiaphragmatic interposition (Fig. 6). After several weeks in the hospital there was a remission of symptoms. There is no follow-up.

Comment. This case does not meet all of the criteria of a gastric volvulus since a negative roentgen examination of the stomach was not obtained. However, it is believed an organo-axial volvulus, associated with an unusual position of the colon.

Case vi. (From the files of University Hospital, Charlottesville, Virginia.) H.M.J., colored, female, aged thirty-eight. There was a history of intermittent abdominal pain for four years. The chief complaint was "stomach trouble" with mild aching and tenderness in the epigastrium. The abdomen was distended. There had been no episodes of nausea and vomiting.

Roentgen examination showed an eventration of the diaphragm on the left. On examination of the upper gastrointestinal tract, the pars media was rotated to a position superior to the level of the cardia and antrum. The antrum was pulled upward along with the bulb, the pull of the gastrohepatic ligament causing the bulb and antrum to point downward. The esophagus entered the stomach in a dependent position. Two fluid levels were well demonstrated in the stomach, one in the cardia and one in the antrum (Fig. 7). The findings were unchanged during three examinations over a period of two months until during the third examination, in the prone position, the stomach resumed its normal position. Three months later the stomach initially presented a rotated appearance and it was again determined that, in the prone position, it was subject to reduction to normal position.

Fig. 7. Case vi. Organo-axial volvulus. The rotation of the greater curvature to a superior position, two separate fluid levels, one in the cardiac portion and one in the antrum of the stomach, are well demonstrated. The antrum is pulled up causing the bulb to point downward. In the prone position this stomach resumed its normal position upon occasion.

Comment. It is believed that the organo-axial volvulus was concomitant with diaphragmatic eventration. When intra-abdominal pressure on the stomach was lessened, in the prone position, the stomach would, upon occasion, resume its normal position. This is reported as a case of true chronic gastric volvulus, associated with eventration of the diaphragm.

Case vii. (Case of Dr. V. W. Archer.) B. A., white, male, aged sixty-five. This patient, who was quite obese, was examined because of a secondary anemia of unknown etiology. At the first examination the stomach was high, small, and hyperactive. It emptied quickly and no abnormalities were found. At a subsequent examination a small diaphragmatic hernia was demonstrated, and the stomach was rotated so that its greater curvature was in a superior position, its lesser curvature in an inferior position, and the antrum pulled upward. The bulb and antrum pointed downward (Fig. 8).

Fig. 8. Case vii. Organo-axial volvulus. The greater curvature is seen rotated above the lesser curvature. A portion of the pars media projects through a small diaphragmatic hernia.

In addition to a large, redundant, spastic colon, a filling defect was demonstrated in the cecum. At operation a carcinoma of the cecum was found.

Comment. A case of organo-axial volvulus which apparently was unconnected with the patient's symptoms has been presented. Obesity, redundancy of the colon, and diaphragmatic hernia all may have been etiological factors in the production of this abnormal rotation.

Case viii. (From the files of Lawson General Hospital, Atlanta, Georgia.) White male, aged twenty-five. This patient was in an automobile accident which caused three ribs to be fractured. He immediately developed difficulty in breathing. The line of demarcation between the left lung and abdominal viscera on the left was high and a tentative diagnosis of traumatic diaphragmatic hernia was made. When first seen here his complaint was of vague discomfort in the epigastrium when walking. His induction roentgenogram showed a normal left hemidiaphragm. Gastrointestinal studies showed the esophagus entering the cardia in a dependent position. The greater curvature of the stomach was rotated above the lesser. The antrum was pulled upward and the bulb pointed downward (Fig. 9). The colon, except for an unusually high splenic flexure, was normal in position. Since roentgenoscopic study with barium in the stomach in the routine Trendelenburg position had failed to confirm the presence of a traumatic hernia, air was injected into the peritoneal cavity and an upright roentgeno-

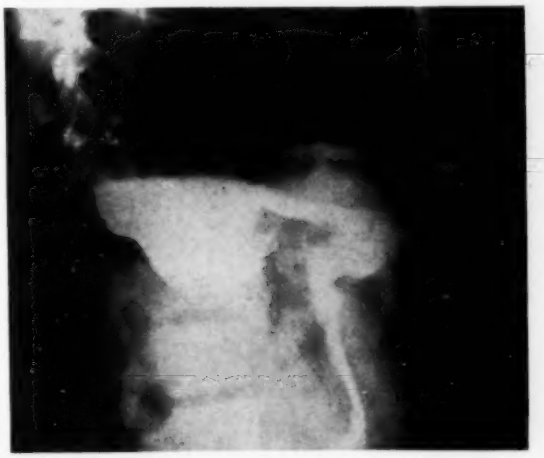

Fig. 9. Case viii. Organo-axial volvulus. The cardia is in a dependent position, the greater curvature is superior to the lesser curvature. The antrum is drawn upward and the bulb points downward. The abnormal rotation of the stomach is associated with a traumatic herniation of the diaphragm.

gram of the chest made just after this showed a pneumothorax (Fig. 10). (Several hundred cubic centimeters of air must be injected for this method to be successful. Previously a lesser amount failed in this patient to produce a demonstrable pneumothorax on the roentgenogram.) Next the patient was placed head down, in an almost upside down position, and due to pressure changes the stomach and some of the small bowel and colon almost entirely filled the left pleural cavity. At operation it was found that the patient had a large traumatic opening in the left hemidiaphragm. This was repaired without difficulty. He stood the procedure well, had an uneventful recovery, and is now asymptomatic. At a postoperative gastrointestinal series the stomach was seen to be in normal position.

Fig. 10. Case viii. Traumatic hernia of the diaphragm. Roentgenogram showing pneumothorax following the injection of air into the peritoneal cavity. The stomach bubble is seen in the left pleural cavity.

Comment. A case of organo-axial volvulus of the stomach, associated with traumatic diaphragmatic hernia, has been presented. The stomach was readily reduced to its normal position at operation.

Case ix. (From the files of Lawson General Hospital, Atlanta, Georgia.) White male, aged nineteen. The patient had suffered occasional twinges of pain in the left axilla for the past several years. Five months before admission he was struck by a truck. He was unconscious for some time. The left patella and fibula were fractured. Two and one-half months following the accident, and one and one-half months following discharge from the hospital, during which time there had been no gastric symptoms, he suddenly developed a severe cramping pain in the upper abdomen. This persisted unchanged for two days and then disappeared. One month later there was a recurrence of symptoms. The pain subsided in thirty-six hours. Roentgenographic and roentgenoscopic examination of the chest showed what was interpreted as a high left hemidiaphragm which moved slightly but synchronously with the right leaf of the diaphragm on respiration.

On administration of the barium meal the cardiac orifice was in a dependent position. Barium flowed upward into a stomach which

Fig. 11. Case ix. Organo-axial rotation. The greater curvature is demonstrated superior to the lesser curvature. The dependent entrance of the esophagus into the cardia is well demonstrated. The antrum and bulb point downward. The finding was associated with eventration of the diaphragm.

was rotated so that the greater curvature was superior to the lesser, and the pars media was above the level of both the cardiac end and the antrum. The antrum and bulb pointed downward (Fig. 11). Associated with this was displacement of the colon in the area of the splenic flexure (Fig. 12). During his stay in the hospital the patient suffered one severe episode of abdominal pain, associated with nausea and vomiting, which lasted a few hours. After this the patient was asymptomatic but the stomach was seen to remain rotated at a subsequent examination.

Comment. A case of organo-axial rotation of the stomach, associated with a probable diaphragmatic eventration, has been presented. Even though the stomach remained rotated, gastric symptoms were intermittent. This case illustrates the difficulty in making a differential diagnosis between eventration and traumatic hernia of the left hemidiaphragm. The usual Trendelenburg position failed to reveal evidence of traumatic herniation and additional diagnostic studies (such as were used in Case VIII) were not carried out.

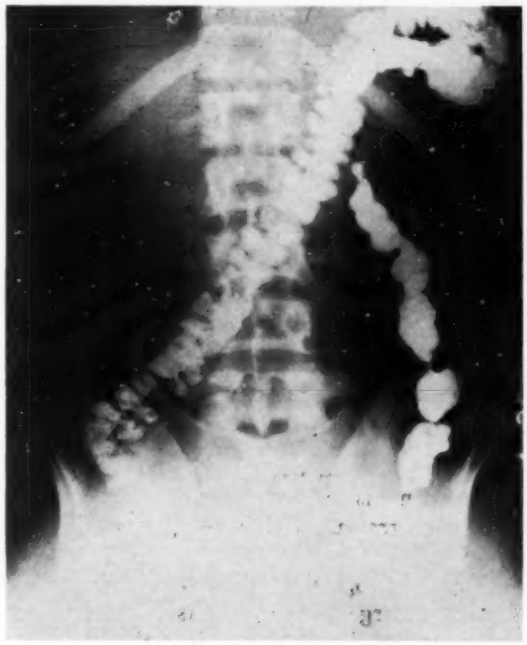

Fig. 12. Case IX. Organo-axial rotation. The unusual twisting of the large bowel associated with the abnormal rotation of the stomach is demonstrated.

Case X. (Case of Dr. P. L. Fisher.) E. R., white, male, aged fifty-four. Three years previous to the gastrointestinal series the patient had been seen and was complaining of sour stomach, belching, and pain in his stomach when it was empty. The chief complaint at the time of this examination was of pain in the stomach, nervousness, and burning. There was some abdominal tenderness.

Fig. 13. Case X. Organo-axial rotation. The abnormal rotation of the stomach under the high left diaphragm is demonstrated. The greater curvature is superior to the lesser. The esophagus enters in a dependent position, the antrum and bulb point downward.

Roentgen examination showed the left hemidiaphragm very high and there was no history of injury to suggest traumatic herniation. The esophagus entered the cardia in a dependent position. The cardia and antrum were below the level of the pars media, which was rotated upward so that the greater curvature was superior to the lesser curvature. Barium first filled the cardiac end of the stomach and finally poured over into the antrum (Fig. 13). Two fluid levels were seen, one in the antrum and one in the cardia. Unlike a cascade stomach in which the cardiac portion forms a pouch hanging down, the body of the stomach was superior to the cardiac portion.

Comment. This is a case of organo-axial rotation of the stomach associated with eventration.

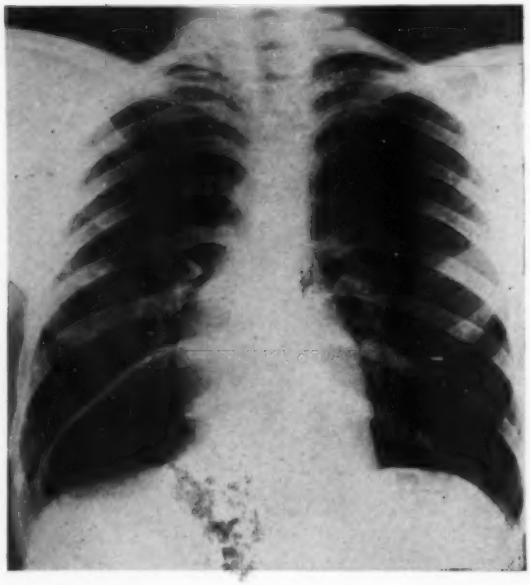

Fig. 14. Case xi. Right-sided thoracic stomach. A large stomach bubble is seen in the right side of the thoracic cavity above the diaphragm. (Note absence of stomach bubble under the left hemidiaphragm.)

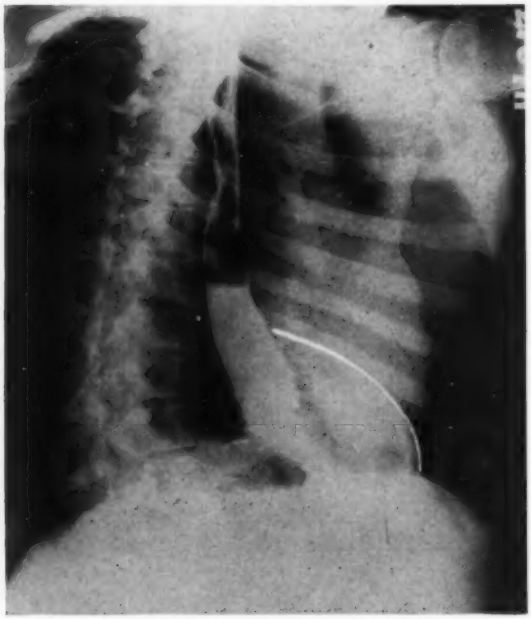

Fig. 15. Case xi. Right-sided thoracic stomach. Right anterior oblique position: The stomach is seen to lie above the right leaf of the diaphragm in an anteromedial position. (Film retouched.)

Case xi. (From the files of Lawson General Hospital, Atlanta, Georgia.) White male, aged twenty-seven. This patient, who was 5 ft. 10 in. in height and weighed 150 pounds, had suffered "stomach trouble" for from six to eight years. There had been a swelling under the short rib on the right, at irregular intervals, which was not influenced by type or quality of food intake. This swelling was associated with a constant pain in the right upper quadrant of the abdomen, and a "quivering of my stomach and my heart beats fast." Nevertheless, for the past

Fig. 16. Case xi. Right-sided thoracic stomach. The stomach lies herniated through the foramen of Morgagni, superior to the right hemidiaphragm. The colon is incompletely rotated. The fold of bowel at the splenic flexure is pulled somewhat to the right by what is believed to be an unusually long gastrocolic ligament.

two years he had been in the Army and able to perform his military duties. There was no history of trauma which could enter into the etiology.

Roentgenological studies were made which showed a large pocket of gas in the thoracic cavity at the right base against the lower border of the heart, displacing the anterior portion of the lower lung upward, posteriorly, and laterally. There was no stomach bubble under

the left hemidiaphragm (Fig. 14). In the left anterior oblique and lateral roentgenograms, the gas pocket was seen to lie anteriorly and above the diaphragm (Fig. 15). A gastrointestinal series showed the esophagus in normal position down to a point 4 cm. above the diaphragm where it turned to the right and sharply upward and was attached to the stomach which lay in the thoracic cavity in the position of the stomach bubble described above. To attain this position the stomach had undergone marked rotation (Fig. 16). A barium enema showed an unusual degree of separation of the stomach from its usual anatomical position with the transverse colon. The colon was not completely rotated allowing a large fold of bowel to be displaced to the right at the splenic flexure.

Comment. An abnormal gastric rotation of a right-sided thoracic stomach (not associated with situs inversus) has been presented. The findings are consistent with a congenital herniation of the stomach through the foramen of Morgagni. Associated with this was an abnormal position of the colon.

DISCUSSION

In all of the cases presented relaxed intra-abdominal attachments are believed to have been present. Obesity, trauma, marked weight loss preceding gastric rotation and anomalous development were varying factors in the etiology of most of the abnormal gastric rotations. A large, redundant, or abnormally situated colon was a feature in several cases of true volvulus. Attention has been called to the transient nature of some of these. Eventration of the left hemidiaphragm was present in 3 cases, in 1 of which there was a true volvulus. In 2 cases of volvulus there was a herniation of the diaphragm, 1 traumatic, the other a small herniation in an obese individual. An unusual congenital variation, a right-sided thoracic stomach, congenitally herniated through the foramen of Morgagni, has also been reported.

Symptoms, while not characteristic, were present in all cases but one, in which case there were none referable to the gastric rotation, which was fleeting in character. In all of the other cases there was discomfort or pain in the epigastrium. In 6 cases there was nausea and vomiting. In several with true volvulus there was a history of similar attacks previously, with a complete remission of symptoms between attacks. Hematemesis and significantly positive benzidine tests on feces were present in only 1 case. Marked weight loss, directly attributable to the rotation of the stomach, was present in only 2 patients.

The characteristic findings in various rotations of the stomach, usually best seen in the upright, posteroanterior position, before the fluroscopic screen, have been described and illustrated. While in some cases the colon is displaced with the stomach, or vice versa, it is interesting to note that in 2 cases there was an extremely long gastrocolic ligament (Cases VIII and XI). It is obvious that in cases of true volvulus the finding may be missed unless the patient is examined during an attack. When there is an eventration of the left hemidiaphragm there may be an organo-axial rotation which is not true volvulus, but true volvulus does occur in the presence of eventration (Case VI).

The differential diagnosis between eventration and herniation of the diaphragm is important since, in the presence of herniation, a repair of the diaphragm, as in 1 case presented (Case VIII) both relieved symptoms and caused the stomach to return to a normal position. In carefully selected cases it is possible that surgery may be helpful in restoring the stomach permanently to a normal position with relief of symptoms.

SUMMARY AND CONCLUSIONS

1. Gastric volvulus implies an abnormal rotation of the stomach of, or approaching, 180 degrees which is not a congenital variation and which is subject to reduction.

2. There are two distinct types of volvulus, organo-axial, the most common, and torsion type, each giving a characteristic roentgenological appearance.

3. Organo-axial volvulus should be differentiated from other abnormal rotations of the stomach, and torsion volvulus from a high lying stomach in the presence of obesity. The differential diagnosis has been discussed.

4. There is little or no similarity between a cascade stomach and gastric volvulus.

5. Attention has been called to methods which may be used in differentiating between an eventration of the left hemidiaphragm and traumatic herniation (Case VIII).

6. Etiology and symptomatology have been discussed.

7. One case of torsion type volvulus, six of organo-axial volvulus, one believed to be organo-axial volvulus, two abnormal rotations, which were constant and associated with eventration of the diaphragm, have been reported. In addition, one congenitally right-sided thoracic stomach (not associated with situs inversus) herniated through the foramen of Morgagni, has been reported.

I am especially indebted for help in writing this article to V. W. Archer, M.D., University Hospital, Charlottesville, Virginia; to various members of the staff of the University Hospital, Charlottesville, Virginia, and of Lawson General Hospital, Atlanta, Georgia, as well as to P. F. Fisher, M.D., Tacoma Hospital and Sanatorium, Greenville, Tennessee, who granted me permission to include his case.

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OSTEOCHONDRITIS DISSECANS OF THE SUPRATROCHLEAR SEPTUM OF THE HUMERUS*

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SIX cases of osteochondritis dissecans in the intra-articular portion of the supratrochlear septum have been observed by us among young adult males during the past two years. Any known antecedent injury was commonly trivial; disability was the most prominent complaint. Of these cases, 5 have been operated upon with consequent confirmation of the diagnosis and relief of symptoms. Five have been considered suitable for reproduction.

Pfitzner[14] (1891), in his study of the sesamoid bones, described a condition at the elbow under the term "sesamum cubiti" which we believe has been subsequently used in error to describe the lesion under consideration.

Reports of but 6 other cases have been found in the literature since the advent of roentgen rays as diagnostic means. Hirsh,[6] Grauer,[5] Winckler,[16] Atsatt,[1] Kleinberg,[8] and Burman[3] each described a single case of a separate nucleus of bone located either in the supratrochlear septum or extruded into the elbow joint proper. Although an associated defect was present in the supratrochlear septum, the concept of the ossicle as a sesamum cubiti was generally entertained. This supposed sesamoid was thought to become intra-articular by some means, and in one instance was believed to have been pressed into a pre-existing supratrochlear foramen.[6] In commenting on Grauer's case, Köhler[10] doubted that the ossicle was either an accessory epiphysis or a sesamum cubiti and suggested that further anatomical study might shed light on the matter.

Histopathologic findings were not recorded in any of the reported cases although in 3 instances the ossicle was removed.[1,5,16] In none was a definite occupational predisposition established; trifling injuries preceded symptoms in the majority of cases.

As a result of the increasing use of the diagnostic roentgenogram, we believe that a sesamum cubiti, more properly termed "patella cubiti," does occasionally appear as an inconstant sesamoid in the triceps tendon.[7,9,13] This is entirely independent and different from osteochondritis dissecans of the supratrochlear septum.

PREDISPOSING ANATOMICAL FEATURES

The supratrochlear septum, usually a thin plate of bone in the distal humerus, lies between the medial and lateral supracondylar ridges just above the trochlea. It separates the coronoid fossa anteriorly from the olecranon fossa posteriorly. The lower portion of the septum is intra-articular on both the anterior and posterior surfaces.[4] Although commonly a complete osseous plate of varying thickness, thinnest at the base, it may in the process of development become perforated to form the "supratrochlear foramen."[11] This variant is said to be less frequent in the more highly developed mammalia and even among the more civilized humans than the aboriginal (Miller, quoted by Hirsh). It is not present at birth nor in the early years before the fossae and processes of the ulna approach their mature form, although such is said to have been observed as early as the seventh year. As the humerus develops, a possible disturbance of local blood supply may ac-

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count for the loss of continuity resulting in a supratrochlear foramen in one and the development of the nucleus of an osteochondritis dissecans in another. Such a vascular disturbance, perhaps incident to minor traumata, would conform to the rather widely accepted theory of the etiology of osteochondritis dissecans in other joints. We have observed either a tion at the knee, in which a long cruciate spine is commonly associated with an osteochondritis dissecans of the medial femoral condyle,[15] and may possibly be the contributing traumatic agent.

THE LESION

As in osteochondritis dissecans elsewhere, roentgenologic studies of the elbow

FIG. 1. Case 1. L. L., aged twenty-one. With no history of direct injury, the left elbow locked and was painful for four days. The pain recurred in three months and lasted two days. Examination revealed a 40° diminution of flexion and extension of left elbow.

Roentgenographic examination demonstrates (*A*) a single circular osseous nucleus situated in the supratrochlear septum of the left humerus. A clearly defined translucent zone borders the nucleus; this is the fibrous tissue replacement zone where separation occurs. In (*B*) the arrows indicate the undisplaced ossicle in the supratrochlear septum. The opposite elbow (*C*) demonstrates an extremely thin supratrochlear septum which occupies an identical site and is of similar contour to the defect on the left side. (Reproduced by permission from the *Journal of Bone and Joint Surgery*, January, 1945, *27*, 12–24.)

supratrochlear foramen or an unusually thin septum in one arm and osteochondritis dissecans in the opposite one in 4 of our cases (Fig. 1*C*). Removal of the osteochondritic nucleus results in a defect of similar roentgenologic appearance to that of a supratrochlear foramen (Fig. 3*C* and 4*C*). This further suggests a common basic etiology.

Although the site would appear unusual, in that it is not a condylar surface, abutment of the olecranon process or the coronoid process of the ulna respectively in full extension or flexion is possible. Such may then be considered analogous to the situation in the classical case discloses a circular button of bone lying in the olecranon or coronoid fossa intimately in contact with the lower and intra-articular portion of the supratrochlear septum (Fig. 1 and 2). The ossicle or nucleus has a somewhat more dense periphery which in turn is bordered by a translucent zone of varying thickness, depending on the degree of separation. Partial or completely free extrusion into the contiguous joint space may occur.

In some cases the nucleus may be fragmented, with several osteocartilaginous bodies of amorphous and granular appearance in the humero-ulnar joint (Fig. 3 and

Fig. 2. Case II. R. J. W., aged thirty-two. Patient was a carpenter before joining the Navy. Onset of symptoms occurred fifteen years previously with sharp pain in the right elbow. Attacks occurred intermittently every two weeks to six months; the last occurred after playing baseball. Excessive hammering was stated to be responsible for similar attacks. Maximum tenderness was above olecranon process. Seventy per cent flexion and extension was present in right elbow.

Roentgenograms (*A*) and (*B*) illustrate an ossicle almost identical to that shown in Figure 1. Note the translucent zone centrally, the increased bony density at the periphery and the bordering translucent zone of separation.

The ossicle was removed at operation and subsequent roentgen examination disclosed a perforate septum formerly occupied by the removed fragment. A supratrochlear foramen was present in the opposite elbow. (Reproduced by permission from the *Journal of Bone and Joint Surgery*, January, 1945, *27*, 12–24.)

Fig. 3. Case III. E. P. M., aged twenty-four. This patient, a Chief Petty Officer, has been in the Royal Canadian Navy for seven years as a gunner. He was serving on two Canadian destroyers at the time of their sinkings. He recalls no elbow injury although he was admitted to a hospital in England with concussion and abrasions. The first attack of pain in the right elbow occurred five years ago, without aggravating circumstances. The second attack occurred one year ago and he was under medical observation for five months, when operation was performed.

Roentgenographic examination (*A*) illustrates an ossicle which has sequestrated from the supratrochlear septum and is situated in the coronoid fossa as shown in (*B*). In this instance the ossicle appears amorphous. It has apparently fragmented, as a second intra-articular ossicle is shown at the olecranon tip (*A*) and (*B*). This has possibly arisen from the upper portion of the main fragment where a local translucency is seen. (*C*) demonstrates what is now a supratrochlear foramen following removal of the large nucleus which was unattached. Note the marginal increase in density. This projection was taken in semi-extension to obviate superimposition of the olecranon tip and the septum. A supratrochlear foramen was present in the opposite side. (Reproduced by permission from the *Journal of Bone and Joint Surgery*, January, 1945, *27*, 12–24.)

FIG. 4. Case IV. A. S. C., aged nineteen. Pain first occurred in February, 1943, following a softball game, and lasted for a week. There was limitation of movement and treatment was a sling for the elbow. In December, 1943, he had a sharp recurrence; at this time tenderness was present in the cubital fossa and flexion and extension were limited.

Roentgenographic examination (*A*) illustrates a septal perforation with an amorphous and faintly calcified nucleus centrally. (*B*) reveals this sequestrum to be situated in the coronoid fossa. (*C*) and (*D*) demonstrate the elbow after removal of the ossicle. Note an ossicle now present in the olecranon fossa. This is also seen in (*A*) overlying the capitellum and was erroneously interpreted as a bone island. (*A* and *B* reproduced by permission from the *Journal of Bone and Joint Surgery*, January, 1945, *27*, 12–24.)

FIG. 5. Case V. T. K., aged thirty. Four years ago, injury occurred to left elbow with pain lasting one week. Two years ago, while throwing a dunnage bag weighing 100 lb., the left elbow locked.

Roentgenographic investigation discloses evidence of osteochondritis dissecans of both the supratrochlear septum and the capitellum. In (*A*) and (*B*) the calcified, amorphous, loose bodies are shown both in the coronoid fossa and above the head of the radius. Note the irregular contour of the capitellum and the small focus of diminished density at its lower condylar surface. (*C*) and (*D*) illustrate this elbow following removal of the ossicles. The septum is of irregular density and is now seen to be composed of multiple perforations and excavations. (*A* and *B* reproduced by permission from the *Journal of Bone and Joint Surgery*, January, 1945, *27*, 12–24.)

4). Still in others, multiple small osteocartilaginous fragments are sequestrated; the supratrochlear septum in such cases has an irregular density suggesting multiple incomplete defects or excavations (Fig. 5).

Osteochondritis dissecans was also present in the capitellum of the same humerus in 1 case (Fig. 5).

Generally, the opposite elbow revealed either an unusually thin or a perforate supratrochlear septum (Fig. 1*C*).

Clinically, these lesions would appear to be dormant for the major period of their development. After a seemingly trivial injury, the patients have presented themselves with the complaint of pain and limitation of movement at the elbow. The clinical findings, reported in detail elsewhere,[12] suggest in certain cases a recent shift in the position of the ossicle. In these, symptoms slowly subside with conservative treatment. If there has been an extrusion of the sequestrum, locking may occur and symptoms will persist and may increase. Removal of the osteochondritic ossicle in 5 cases led to complete recovery without known recurrence of symptoms.

Histopathologic examination of the removed ossicles in 5 cases disclosed the presence of marginal fibrous tissue replacement of bone, which corresponds to the bordering zone of translucency seen in the roentgenogram. Both normal and dead bone is present which accounts for the varying roentgenographic density of the ossicle. Ill defined, swollen, and also normal cartilage is seen. Occasional foreign body giant cells are demonstrated, and there is evidence of increased vascularity. These findings are illustrated in Figures 6 and 7. This distribution and character are similar in pattern to that of osteochondritis dissecans found elsewhere.[2] There is no evidence of an infective etiology.

Fig. 6. Low power photomicrograph of the removed ossicle in Case 11. This discloses a fibrous tissue border surrounding the ossicle. Swollen and ill defined cartilage cells are present at the left with normal and dead bone at the right. (Reproduced by permission from the *Journal of Bone and Joint Surgery*, January, 1945, *27*, 12–24.)

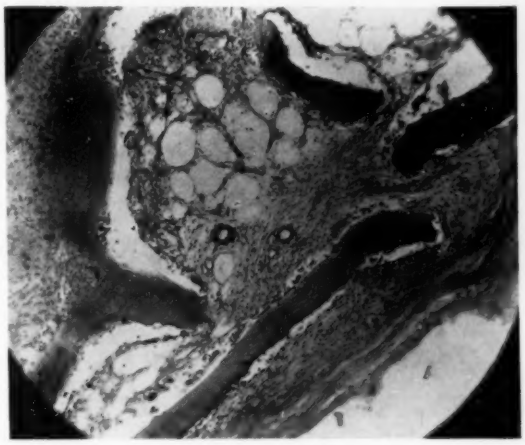

Fig. 7. High power photomicrograph of the removed nuclei from the supratrochlear septum of Case v. This illustrates the presence of a fibrous tissue bed at the left which has replaced the adjacent bone. Bone marrow fat cells are present centrally. Osteoclasts are at the periphery of the bony spicules shown at the right and here a few foreign body giant cells are present. Note the rather abundant arterioles and venules. (Reproduced by permission from the *Journal of Bone and Joint Surgery*, January, 1945, *27*, 12–24.)

SUMMARY

A localized lesion of the intra-articular portion of the supratrochlear septum of the humerus, previously confused with sesamum cubiti, has been shown to be an osteochondritis dissecans.

A supratrochlear foramen or thin septum in the opposite humerus is common and lends credence to the theory of vascular abnormality during growth as a predisposing cause. Local impingement of the coronoid or olecranon processes may be a contributory primary agent.

Symptoms may not exist or remain subclinical for a considerable time. The minimal traumata associated with the onset of clinically noticeable symptoms cannot be considered the major causative agent.

Extrusion of the nucleus as a loose body in the joint may occur.

Surgical removal affords complete relief of symptoms.

The authors wish to express their appreciation to Surgeon Commander C. B. Peirce, Consultant Radiologist, R.C.N., for his advice in the preparation of this paper; also to the late Dr. G. A. McCurdy, Director, Department of Pathology, Royal Jubilee Hospital, Victoria, B. C., and to Dr. C. Yuille, Department of Pathology, McGill University, Montreal, Quebec, for their assistance in the preparation and interpretation of the histopathologic findings.

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NEOPLASMS OBSERVED IN AN ARMY GENERAL HOSPITAL

REPORT OF THREE CASES: TWO CYSTS OF THE MEDIASTINUM AND A FIBROMA OF THE STOMACH*

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A GENERAL HOSPITAL is established by Army Regulations "to study, observe and treat the more obscure and more complicated cases." Therefore, in such a selected group of cases the number of neoplasms encountered is higher than might be anticipated in men of average Army age.

An analysis of the first 3,045 admissions to this hospital reveals that a diagnosis of neoplasm was made in 45 instances. Thirty of these men were admitted because of a tumor, while such a finding was incidental in the remaining 15 cases.

As indicated in the tables, 28 of the tumors were benign, while 17 were malignant. The location and type of tumor and, in the case of the malignant neoplasms, the age of the patient are shown.

It is to be noted in Table II that carcinoma of the lip and the lower large bowel occurred with much greater frequency in younger individuals than would normally be expected.

Because of their roentgenologic interest 3 of the more unusual benign tumors are here reported.

Two are cases of mediastinal tumors—a dermoid cyst and a teratoma. Roentgeno-

TABLE I

BENIGN NEOPLASMS 28

Location	Type	No.
Bone	Chondroma, enchondroma, etc.	4
	Bone cyst	1
	Osteoma	1
	Giant cell tumor	1
	Dentigerous cyst—mandible	1
Skin	Lipoma	7
	Fibroma	2
	Hemangioma	1
Rectum	Papilloma	1
Nose	Mixed tumor (cartilaginous)	1
Eye	Pigmented nevus	1
Thyroid	Adenoma	3
Mediastinum	Dermoid	1
	Teratoma	1
Stomach	Fibroma	1
Spinal cord	Xanthoma	1
	Average age 22 yr.	

TABLE II

MALIGNANT NEOPLASMS 17

Location	Type	Age yr.	No.
Bone	Chondromyxosarcoma (tibia)	20	1
	Anaplastic periosteal sarcoma (mandible)	20	1
Skin	Carcinoma	23, 23	2
Lip	Carcinoma	23, 25, 28, 29	4
Rectum and sigmoid	Adenocarcinoma	28, 29, 34, 45	4
Eye	Malignant melanoma	21	1
Brain	Malignant glioma	29, 34	2
Pancreas	Carcinoma	58	1
Testicle	Seminoma	28	1
		Average age 29	

* From the Hoff General Hospital, Santa Barbara, California.

Fig. 1. Case 1. Dermoid of mediastinum.

graphically, these tumors both present a more or less sharply circumscribed, often superior and predominantly anterior extra density in the chest (Fig. 1, 2, 4 and 5). According to Hammarskjöld[4] dermoids are more sharply outlined than teratomas. The mediastinal structures are often displaced by these tumors. Phemister, Steen and Volderauer[8] noted that a fluid level may be seen at times in dermoid cysts (Fig. 1 and 2). This is attributed to the layering of lighter oils present within the cysts. Roentgenoscopically, transmitted pulsation is seen. Where the tumor is firmly lodged between the bony thorax and the heart or great vessels, the pulsation may appear to be expansile.

The most frequent symptoms are chest pain, cough and dyspnea.[3] Hemoptysis sometimes occurs and the coughing up of hair is pathognomonic of mediastinal dermoid eroding a bronchus.[6] Adequate and complete surgical removal is indicated, for rupture of the tumor may lead to pneumonia or empyema.[5,9] Moreover, malignant degeneration is not uncommon.[3]

Case 1. *Dermoid cyst of mediastinum.* J.W.W., white, aged twenty, soldier of the Regular Army who had had one year and ten months of duty. He had been well and had had no chest symptoms. Five weeks before admission to this hospital he developed a severe earache on the right, accompanied by a high fever, headache and pain in the left chest. He was hospitalized near his station. The left chest was aspirated and a relatively large amount of fluid was removed. The nature of this was not learned. At that time numerous roentgenograms of the chest were taken and a "cyst-like formation" was found in the left chest anteriorly. Two attempts were made to aspirate the cyst. Two weeks after the onset of his illness swelling of the left leg was noted.

On admission to this hospital his pulse was 100 and his temperature was normal. The blood pressure in the right arm was 152/92, in the left 105/90. He appeared rather pale and underweight, and there was slight swelling of the left leg. In all other respects his general physical examination was essentially negative except for the chest where, in the second and third interspaces on the left, the retromanubrial dullness was increased. In this area the breath sounds were somewhat diminished. The labora-

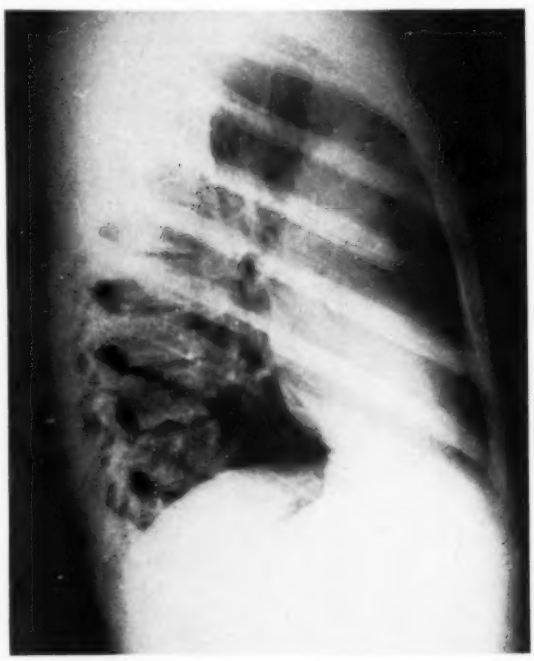

Fig. 2. Case 1. Dermoid of mediastinum.

tory findings, including the blood count, urinalysis and serology, were not unusual.

Roentgenograms of the chest (Fig. 1 and 2) and roentgenoscopic examination revealed a sharply outlined, rounded shadow of approximately maximum cardiac density at the level of the second and third anterior interspaces to the left of the midline and above the left ventricular outline. It was seen to be anterior and, in its apex, there was a visible air or lighter fluid shadow (Fig. 2). This latter finding disappeared and could not be seen on later roentgenograms. During the following month the cyst did not increase in size.

His general condition improved and the thrombophlebitis of his left leg subsided, although this leg remained slightly larger than the right. One month after admission the tumor was removed by Captain Paul C. Samson through an anterior incision with removal of a segment of the third costal cartilage. Endotracheal anesthesia was used. The phrenic nerve was seen to pass through the wall of the tumor and was sacrificed. Postoperatively several aspirations were required to remove pleural fluid, but the chest rapidly cleared (Fig. 3). He was returned to duty symptom free.

Pathological Findings. The cyst was opened at surgery and was received in a collapsed state. Its contents were seen to be approximately 1 ounce of soft, brownish granular material having the consistency of cottage cheese and in which a few hairs floated. No structures were found which could be said to be teeth. The cyst, when reconstructed, measured about 6 cm. in diameter, and showed, on its external surface, many tags of fibrous tissue which were quite vascular. A small, encapsulated nodule measuring 5 mm. was found attached to the cyst wall externally and appeared to be a lymph node. On section it contained a necrotic, cheesy material. On the internal wall of the cyst there was a plaque of firm tissue measuring 3 cm. in diameter which grossly suggested cartilage. A white streak was buried in the adjacent cyst wall measuring 2.5 cm. in length and this was thought to represent a nerve fiber. Otherwise the cyst was uniformly thin, averaging about 1 mm. in thickness.

Microscopically the cyst wall was seen to be made up of fibrous tissue which was more or less laminated due to the pressure of the cyst contents. Marked pigment deposition was noted to suggest old hemorrhage, and scattered

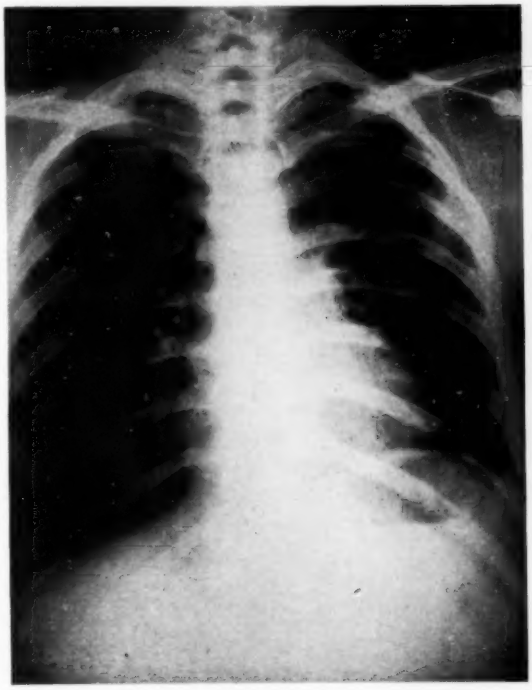

Fig. 3. Case 1. Dermoid of mediastinum at discharge from hospital.

areas of calcification were seen, particularly in the plaque described grossly. Cholesterol clefts and deposits were apparent. Attached to one wall was a considerable portion of lymphoid tissue which contained definite Hassall's corpuscles of thymus gland. No evidence of malignancy was seen. Diagnosis: Dermoid cyst of the mediastinum, benign.

Case II. *Teratoma of mediastinum.* F.M., white, aged twenty-two, selectee, who had been in the Army but four months. He had been entirely well until one month before entering the Service when he first noted a fleeting sharp pain in the upper anterior chest when he held his left arm in certain positions. This did not concern him greatly. However, soon the pains became more frequent and more prolonged, gradually changing to a dull, persistent aching which was more severe when he was exposed to cold or wet weather. Change of position seemed to aggravate his discomfort. One month before admission he was seized by a sudden, severe chest pain and had considerable difficulty in getting his breath. The attack lasted for three or four hours and there were no recurrences. He was hospitalized at his camp for this, how-

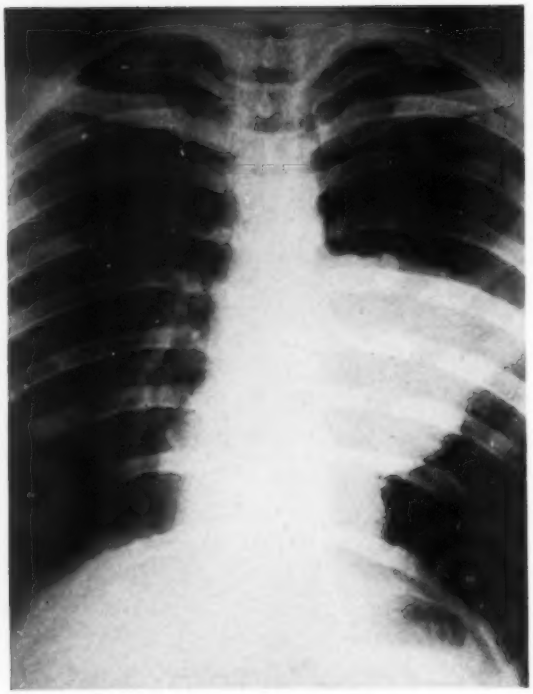

Fig. 4. Case II. Teratoma of mediastinum.

ever, and a gradually increasing cough productive of small amounts of yellowish sputum appeared which aggravated his pain and caused some dyspnea. About two weeks before his transfer to this hospital a tonsillectomy was performed.

At the time of his admission he complained of the cough, chest pain and dyspnea on exertion. He had noted no dysphagia, and a general review of his symptoms revealed no other abnormalities. His temperature was normal and his general physical examination was essentially negative except for the chest where there was some increase in the retromanubrial dullness in the third and fourth interspaces to the left. The blood pressure in the right arm was 130/75 and in the left, 138/72. A slight leukocytosis was attributed to his recent tonsillectomy.

Roentgenograms of the chest (Fig. 4 and 5) and roentgenoscopic examination revealed a large tumor mass which extended from the hilum anteriorly and laterally on the left and which displaced the heart and mediastinal contents downward and to the right. It was sharply outlined by normal air containing lung except on its extreme lateral margin where a zone of increased density suggested compression of the adjacent tissues. It measured approximately 10 cm. in each of its greater diameters. In the lateral projection it was seen to be firmly placed between the anterior chest wall and the heart and great vessels. Expansile type pulsation was marked.

One month after admission the tumor was removed under endotracheal anesthesia by Captain Paul C. Samson. The third and fourth cartilages on the left were removed and a rounded, semisolid mass was shelled out. The phrenic nerve was dissected free from the posterior wall of the cyst. Postoperatively, he rapidly regained his strength, and was up on the tenth day, and at the time of return to duty (Fig. 6) showed only moderate fibrosis at the former site of the tumor.

Pathological Findings. A rounded cystic mass was received which measured approximately 10 cm. in two directions and 12 cm. in its longest diameter. Its external surface was smooth yellow blending into pink and white. On one portion of the surface vascular fibrous tissue could be seen. The contour of the wall was broken by projections or nodules, six or so in number, which varied in size from 1 to 4 cm. and had an average elevation of 1.5 cm. The entire mass was tense and cystic. On its cut

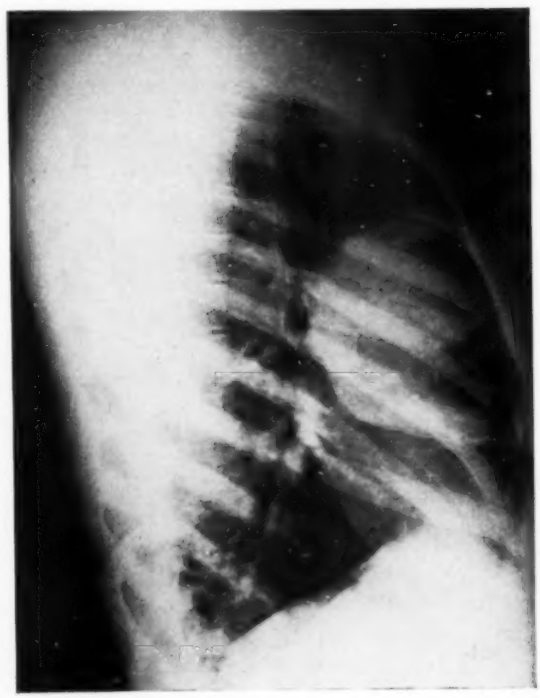

Fig. 5. Case II. Teratoma of mediastinum.

surface, when bisected, a large group of fatty lobules occupied one area. They were separated by septa of dense white tissue which appeared fibrous in some areas and cartilaginous in others. Other zones contained numerous cystic cavities varying in size from 1 mm. to 1.5 cm., some of which contained a clear, thick, mucoid material. A few of these suggested ducts and several were apparently lined by mucosa. Where the cartilage was densest, the cut surface revealed a dark red central portion suggesting bone marrow. Other cystic spaces contained sebaceous material and hair. Gland tissue was identified in one portion. In general, the tumor was not very vascular.

Microscopically, the large yellow lobules noted grossly were fat tissue, and the dense white septa were fibrous tissue with many small hemorrhages throughout. One section revealed thymic tissue represented by Hassall's corpuscles in lymphoid tissue. Other sections from the inner portion of the tumor showed the cystic and duct-like areas to be lined by various types of epithelium or only by a rather dense, laminated fibrous tissue. Hyalin cartilage formation was apparent lying in a lobule of fat tissue, and bundles of smooth muscle fibers were seen which appeared somewhat interlaced as in the myocardium. One cyst was lined by a stratified or pseudostratified columnar epithelium suggesting respiratory tract lining. Other areas were seen, lying within the fibrous tissue, which were lace-like and composed of thin strands of tissue in which there were scattered and isolated nuclei. These nuclei had rather distinct nucleoli but poorly outlined cytoplasmic envelopes. This particular tissue resembled white matter of the central nervous system. Mixed type, mucus secreting glands were found, and skin with stratified squamous epithelium and sebaceous glands was identified. The lining of several spaces was that of small intestine, while in others large intestinal mucosa was described. The structure grossly thought to resemble gland tissue proved to be a fairly large, lobulated gland in which ducts could be seen. It had the appearance of pancreas. Bone was present with trabeculae, around and between which connective tissue and large blood sinuses were found. There was a large cellular collection but no definite evidence of hematopoiesis. Diagnosis: Mediastinal teratoma, benign.

The third benign tumor was a fibroma

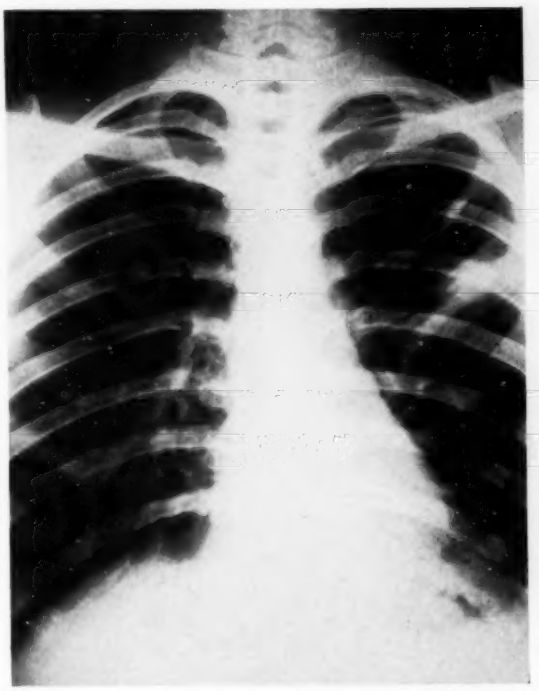

Fig. 6. Case 11. Teratoma of mediastinum at discharge from hospital.

of the stomach. Benign gastric neoplasms are rare, representing less than 0.5 per cent of all gastric tumors at the Mayo Clinic.[1] In a series of 931 such tumors collected from the literature by Minnes and Geschickter[7] there were but 42 fibromas, representing about 4.5 per cent. Roentgenographically, benign tumors of the stomach are characterized by absence of infiltration of the stomach wall and by the uninterrupted flow of peristalsis over the tumor.[2] In the case here presented the mass was so large that neither of these phenomena could be observed. A smooth outline of the tumor is suggestive of benignity. The potential malignancy of a gastric fibroma is unknown, but spindle cell sarcoma, a rare entity indeed, has been reported.[1] Mechanical obstruction as in the following case is frequently the cause of the symptoms.

Case III. *Fibroma of the stomach.* A.L., white, aged twenty-five, selectee, who had been in the Army for five months. He had had no symptoms or complaints relative to his stomach until six weeks before admission. At that time there was

Fig. 7. Case III. Fibroma of stomach.

a gradual onset of abdominal pain, mid-epigastric in location and cramping in type. His appetite was then good and he obtained relief from his symptoms by vomiting. However, the pain gradually increased as did the vomiting and soon he lost all desire for food. There was no hematemesis. No tarry stools were noted but the patient was constipated. There was no history of jaundice.

On admission to the Hoff General Hospital he was found to be a fairly well nourished young man who had obviously lost some weight. His general physical examination, including pulse, temperature and respirations, was essentially negative. The only positive finding was a palpable mass in the right upper quadrant just below the costal margin which was only to be felt when the patient was standing. There was a leukopenia of 2,500 and a very slight anemia.

The roentgen examination of the stomach showed considerable fluid and food retention although the patient had not eaten for over twelve hours. The stomach was dilated but had surprisingly good tone and showed ineffectual peristalsis. In the distal third the barium was displaced by a large mass which extended beyond the usual position of the pylorus and which obscured the upper portions of the duodenum (Fig. 7). It was roughly egg shaped and measured 6 by 8 cm. It seemed to lie anteriorly and barium could be discerned on all of its borders, indicating that it was within the lumen of the stomach. It could not be moved within the stomach.

A gastroscopy was done but the pylorus could not be visualized and therefore some doubt was expressed as to how much of the antrum had been viewed. The proximal two-thirds of the stomach was considered to be essentially normal.

Two weeks after admission the abdomen was opened by Major Walter Birnbaum through an upper abdominal incision. When the stomach was opened the tumor was seen to arise from the posterior gastric wall in the immediate region of the pylorus. The distal third of the stomach was resected and a Billroth gastroduodenostomy was done. The patient was convalescing satisfactorily at the time of this report.

Pathological Findings. The specimen was the distal third of the stomach which had been opened along the lesser curvature (Fig. 8). Attached to the posterior wall and projecting into the lumen was a firm, rubbery and fairly smooth tumor mass which measured 9 by 5 by 5 cm. The area of attachment measured about 5

Fig. 8. Case III. Fibroma of stomach, operative specimen.

cm. About this pedicle, tumor tissue was palpated in the stomach wall. It was more nodular than the intraluminal portion. The area of mural involvement measured 7 by 5.5 by 5 cm. and represented slightly less than two-thirds of the total mass. The mucosa of the surrounding stomach wall appeared intact, while the tumor covering appeared to lack epithelium. No tumor was found on the serosal surface and a complete capsule was thought to be present. There was slight thickening 2 cm. from the distal end which was thought to represent the pylorus, now totally distorted.

On section the tumor cut with some resistance and grating, and the surface thus revealed appeared not unlike a uterine fibroid. There were whorls of white fibrous tisue with a central portion of increased translucency which exuded a clear fluid and suggested degenerative change. No cystic changes were noted.

Microscopically, the tumor was separated from the serosa by a fairly definite layer of stomach wall. The mucosa of the stomach was quite normal in appearance but did not extend over the intraluminal portion of the tumor which was covered by a thin capsule of flattened fibrous tissue cells. The tumor itself was composed of strands of collagenous tissue which in some places were in parallel bundles, and in others quite irregular in arrangement. It was relatively cellular, with fairly uniform nuclei. A few blood vessels were seen throughout the tumor which were normal in appearance. Van Gieson's stain showed the tissue to be fibrous, no muscle being demonstrated except in the vessel walls. In the soft central portion myxomatous degeneration was found, with the fibroblasts assuming spindle and stellate shapes. There were no mitotic figures and no evidence was found of extension into the lymphatics or vessels. A section of the distal portion of the stomach revealed large Brunner's glands in the submucosa, indicating that the excision included the pyloric ring and a small portion of the duodenum.

Diagnosis: Benign fibroma of the stomach with myxomatous degeneration in its central portion.

SUMMARY

Forty-five tumors encountered in 3,045 admissions to Hoff General Hospital have been listed. Three cases of unusual interest have been discussed in detail.

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INTERSTITIAL EMPHYSEMA AND PULMONARY COLLAPSE COMPLICATING FRACTURES OF THE SKULL

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Medical Corps, Army of the United States

THE purpose of the present examination is to call attention to the fact that fractures of the skull may be associated with interstitial emphysema and pulmonary collapse.

CASE REPORT

C.K. (No. C-475), a Chinese male, aged twenty-five, was admitted to the Neurosurgical Section of an overseas general hospital in an unconscious state at 0540 hours on May 1, 1943. The patient had been shot through the head about two hours earlier.

Examination. The patient was a short, well developed individual. He was unconscious and reacted feebly to painful stimuli. Respirations were stertorous, forced, and rapid (40 per minute). With each expiration foamy mucus was blown out of the mouth. The pulse rate was about 180. The head was covered with coagulated, dried blood. Palpation of the skull revealed diffuse subgaleal bleeding. Crepitus could be elicited by gentle pressure over the left frontal bone. A scalp wound about one-half inch in diameter was easily identified in the left parietal region. Examination of the remaining portions of the body revealed no gross abnormalities. The patient was in severe shock.

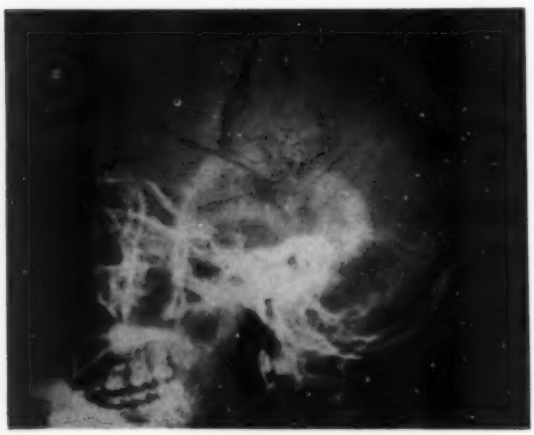

FIG. 1. Lateral roentgenogram of the skull revealing the bone defect produced by the bullet. The multiple lines of fracture are well visualized.

Neurological examination showed the pupils to be equal and of moderate size. They did not react to light. The right arm and, to a lesser degree, the right leg were spastic. The left arm and leg moved slightly when stimulated. No reflexes could be elicited.

The response to treatment was unsatisfactory. The patient remained in shock in spite of the intravenous administration of plasma and other fluids. Respiration became more difficult and forced. All the accessory respiratory muscles seemed to be brought into action with each inspiration. The respiratory rate gradually increased to 64. The foamy mucus blown from the mouth with each expiratory effort became more abundant and bloody. Frequent oral aspiration by means of a soft rubber catheter failed to control the discharge.

At 1000 hours, interstitial emphysema of the neck and upper chest wall was first noted. An adequate physical examination of the lungs was impossible because of the noisy respiration. The patient died at 1130 hours, five hours after admission to the hospital, and seven hours following his injury. A necropsy could not be obtained.

Roentgen Examination (completed within a few minutes after death). Head: Numerous fracture lines extending throughout the bones of the calvaria. The wound of entry is marked by a circular bone defect low in the right parietal region (Fig. 1). From this bullet hole at least five fracture lines extend in stellate fashion into the parieto-occipital, parieto-frontal, and parietotemporal regions. The bone defect in the wound of exit is much larger and is located at a higher level in the right parietal region. Fragmentation of bone in this area is excessive. The fracture lines are wide and there is considerable separation of the fragments. Small spicules of bone and bubbles of air are

evident within the brain substance. Examination of the base of the skull reveals clouding of the entire left temporal bone. Fracture lines extending through the region of the tip of the left petrous pyramid and the clivus are easily identified. Neck: The lateral examination of the neck reveals interstitial emphysema involving the soft tissues behind the oro- and nasopharynx extending down into the posterior mediastinum (Fig. 2). Interstitial air is also identified in the soft tissues of the neck in the anteroposterior projection. Chest: The soft tissues of the chest reveal interstitial emphysema (Fig. 3). These changes are part of the process involving the neck and extend into both shoulders and down into the upper portion of the chest wall. The bones of the thoracic cage are negative. The trachea is in the midline. The mediastinal structures are outlined by interstitial air. The lungs are clear, though hypoventilated due to death. There is about 25 per cent collapse of the left lung. The domes of the diaphragm appear normal.

Direct examination of the nasopharynx by a competent observer revealed swelling of the mucous membrane, interstitial hemorrhage, and blood and mucus in the roof of this cavity.

FIG. 2. Lateral roentgenogram of the soft tissues of the neck and nasopharynx. The interstitial emphysema extending from the region of the clivus down the neck and into the superior mediastinum is clearly demonstrated.

FIG. 3. Anteroposterior roentgenogram of the chest made immediately after death. The interstitial emphysema in the neck and lateral chest wall is easily visualized. Note the air surrounding the large blood vessels at the base of the heart. The left lung is partially collapsed.

COMMENT

Nothing is known concerning the nature of this patient's accident. He was brought into the hospital unconscious, failed to rally, and died five hours after admission. The noteworthy physical findings were the cranial injury, profound shock, and rapid stertorous breathing. Roentgen examination revealed multiple skull fractures which were associated with interstitial emphysema of the neck and chest.

DISCUSSION

Unfortunately, it was impossible to obtain permission for a postmortem examination of this patient. This presentation must therefore be considered incomplete. Nevertheless, the presence of interstitial emphysema and partial pulmonary collapse as complicating factors in a patient with a gun shot injury of the head and multiple fractures of the skull seem worth recording. Air within the skull (pneumocephalus)

Fig. 4. Anatomic demonstration of the prevertebral fascial planes. Note the manner in which these fascial planes extend from the nasopharynx downward into the posterior mediastinum.

complicating skull injuries, has been frequently described. The presence of abnormal air in the soft tissues of the chest as a complication of skull fractures is unusual in our experience.

In our opinion, the fractures in the base of the skull were responsible for the interstitial emphysema. These fractures, which extended through the left petrous pyramid and the basilar portion of the occipital bone, were easily demonstrated roentgenographically.

In addition, direct examination of the nasopharynx by a competent observer revealed marked swelling of the mucous membrane, interstitial hemorrhage, and blood and mucus in the roof of this cavity. Whereas, a tear in the membrane lining the nasopharynx was not actually demonstrated, it seemed reasonable to attribute the nasoscopic findings to the basilar fractures which were probably compound. A tear in this portion of the nasopharynx could open fascial planes along which interstitial air could travel and enter the mediastinum.

According to Gray, the nasopharynx is limited above by the body of the sphenoid and basilar part of the occipital bone and is connected posteriorly by loose areolar tissue with the prevertebral fascia. The prevertebral fascia, which assists in forming the sheath of the carotid vessels, gives off the buccopharyngeal fascia which helps to form the retropharyngeal space. This easily distended space is limited above by the base of the skull while below it extends behind the esophagus into the posterior mediastinal cavity of the thorax. We believe the interstitial air demonstrated in our patient traveled along these routes (Fig. 4).

Clinically, the patient presented marked respiratory embarrassment. For at least five hours prior to death, his respirations were characterized by explosive expiratory grunts probably due to the swelling of the tissue of the nasopharynx and the oral mucus which interfered with breathing. We believe that this resistance to the normal respiratory cycle forced air into the loose areolar tissue surrounding the nasopharynx during each expiration. Once initiated, this vicious cycle continued until interstitial air found its way into the posterior mediastinum. Whether the partial pulmonary collapse was due to a pleural tear which allowed the air in the posterior mediastinum to enter the pleural cavity or whether the air, under pressure, stripped the parietal pleura from the chest wall (extrapleural pneumolysis) is a debatable problem. The evidence favors the latter hypothesis.

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VISUALIZATION OF THE CORONARY ARTERIES IN DOGS*

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IN 1938 Robb and Steinberg introduced 70 per cent diodrast as a radiopaque contrast medium to visualize the chambers of the heart and its great vessels. Since then, roentgenographic examination of almost all the arteries and veins has become a routine matter at many institutions. To our knowledge, no method of demonstrating the coronary arteries in the living animal has been brought forth. In 1942 Barclay and his co-workers injected thorotrast retrogradely through the aorta to demonstrate the ductus arteriosus in sheep fetuses. As an incidental finding they pointed out that one of the coronary arteries was seen. This observation prompted the present work. We wish to elaborate this point to show that it is feasible to instill substances directly into the coronary circulation without opening the thoracic cage.

METHOD

Dogs were anesthetized with sodium pentobarbital (25 mg. per kilogram body weight given intravenously). A small incision was made in the mid-neck paratracheally on the right. The right common carotid artery was exposed and freed. The artery was ligated distally and a loose ligature was placed proximally. A bulldog clamp was fixed at the proximal end of the artery after the blood had been milked from the arterial segment between the ligature and the clamp. An incision was made in this arterial segment large enough to admight a No. 10 wax ureteral catheter (the tip of which had previously been bent to an angle of 35° and to the other end of which was affixed a piece of rubber tubing which was clamped to prevent the flow of blood during the insertion). The proximal ligature was tied snugly around the catheter to prevent leakage of blood around the catheter. The proximal clamp was removed from the artery and a small amount of 70 per cent diodrast was injected into the catheter to render it radiopaque. Under roentgenoscopic guidance, the catheter was insinuated until its tip reached the aortic arch. The catheter was then rotated on its longitudinal axis so that the tip pointed ventrally and was then inserted so that the tip was at the level of the most proximal portion of the aorta. This position was tested by injecting about 5 cc. of diodrast and observing its flow roentgenoscopically. If the catheter was properly in place the diodrast momentarily outlined the proximal aorta stopping abruptly at the aortic valves. If the catheter was not in good position the diodrast did not enter the intracardiac portion of the aorta and could be seen coursing along the transverse and descending aorta. In such cases withdrawal and manipulation resulted in good placement. A survey roentgenogram of the heart was taken in the left lateral recumbent position with the catheter in situ. The factors used were: 30 inch tube distance; 100 ma.; 80 kv. (peak) and 1/10 second exposure. The tube was centered just below the shoulder joint. Another roentgenogram was then taken in the same position during forceful injection of approximately 25 cc. of 70 per cent diodrast.

RESULTS

Twelve dogs were used. Of these, 7 were needed for the preliminary studies and the remaining 5 to show the consistency of the technique. The last five injections demonstrated the coronary arteries in each case,

* From the Cardiovascular Department and Department of Roentgenology, Michael Reese Hospital, Chicago. Aided by the Emil and Fanny Wedeles Fund for Cardiovascular Research. The Cardiovascular Department is supported in part by the Michael Reese Research Foundation.

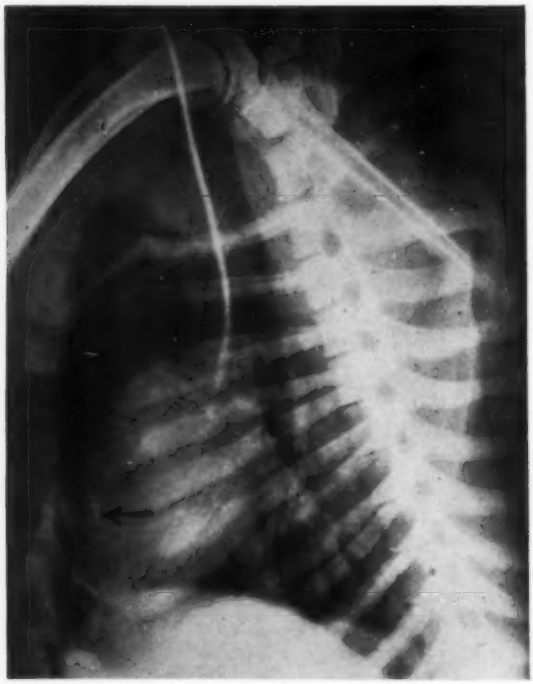

Fig. 1. Left lateral recumbent roentgenogram of dog with catheter in position. The tip of the catheter is in the proximal aorta. Arrow points to a thin wire loop placed around the left anterior descending coronary artery.

although sometimes several trials were necessary. All but one of the dogs in which a successful coronary artery visualization was obtained died. However, in each case several injections were made and from 100 to 150 cc. of diodrast was used. A successful injection usually shows the right and left branches of the coronary circulation arising from the sinuses of Valsalva, following the epicardium ventrally and dorsally. The aorta and its branches are likewise well visualized (Fig. 2). Occasionally the chamber of the left ventricle is also visualized due to flow of diodrast past the aortic valves during systole. To prove that the vessels seen were the coronary arteries, an open chest operation was performed on 2 dogs and a thin copper wire was placed around the left anterior descending coronary artery. Figure 1 shows the wire placed around the radiopaque left anterior descending coronary artery. The left circumflex artery is clearly shown as are the entire aorta, brachiocephalic vessels and the internal mammary arteries. A small amount of diodrast is shown within the chamber of the left ventricle. In 1 instance, the exposure time was long enough to show the aorta in two phases of contraction thereby demonstrating the aortic width during phases of systole and diastole. In another case following injection and visualization of the coronary arteries and aorta the dog died. Another injection was made in this dead dog demonstrating the extensive diminution of the caliber of the aorta after death.

CONCLUSIONS

1. A method is presented for the insertion of foreign substances into the coronary arteries of the living animal.

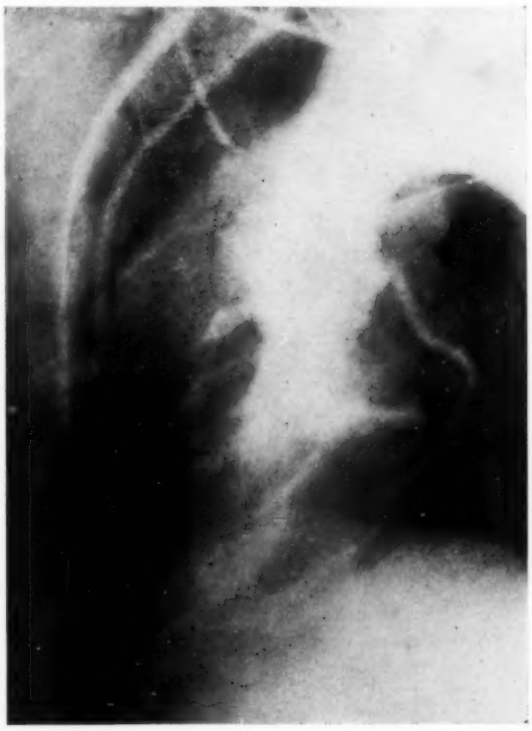

Fig. 2. Same dog as Figure 1 after injection of 70 per cent diodrast with visualization of the left anterior descending coronary artery (note arrow pointing to wire loop around this artery) and a good demonstration of the left circumflex coronary posteriorly. The chamber of the left ventricle and the aorta with its branches are also seen.

2. The coronary arteries can be visualized in the intact living animal by means of the instillation of 70 per cent diodrast.

We are indebted to Winthrop and Co. for supplying the 70 per cent diodrast. I wish to acknowledge the assistance given by Dr. B. Kondo and Miss L. Friedberg, and the guidance of Dr. L. N. Katz.

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IRRADIATION FAILURES IN EARLY CERVICAL CANCER

IMPROVED IRRADIATION OR RETURN TO SURGERY?*

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IT IS now generally accepted that *statistically* the results of adequate radiation therapy are superior to those of the radical Wertheim hysterectomy in the treatment of epidermoid carcinoma of the cervix in all stages. Before this audience I do not have to repeat the statistical evidence that has led to these conclusions.[3]

It is sufficient as a basis for this discussion to recall Regaud's classical comparison between his irradiation results and the surgical results of Jean Louis Faure[10] (Table I).

TABLE I

COMPARATIVE RESULTS OF SURGICAL TREATMENT (FAURE) AND RADIATION TREATMENT (INSTITUT DU RADIUM) OF CARCINOMA OF THE CERVIX UTERI

	Number	Cures	Cures Per cent	Primary Mortality Per cent
Five year cures with radiation therapy (Institut du Radium, Paris, Regaud) 1922–1926				
Total Stage I–IV	380	124	32	2
Stage I	29	23	79	
Stage II	121	50	41	
Stage III	179	50	27	
Stage IV	51	1	2	
Five year cures with radical operations (Hop. Brocat, Paris, Faure)				
Total Stage I–II	90	30	33	19
Stage I	54	22	40	7
Stage II	36	8	22	36

The statistical results reported from the leading radiological clinics throughout the world are remarkably uniform in spite of differences in technique, provided the procedure is adequate. Some surgical results are better than those represented in this table. In optimal cases (probably early Stage I) about an 80 per cent five year cure rate with 6.5 per cent primary mortality was accomplished, while in borderline operable cases (probably Stage II to III) only 25 per cent could be salvaged, with a primary mortality of 30 per cent.[4] Without going into further details of this old discussion, I only want to point out that adequate radiation therapy yields at least results equal to excellent surgery, if the problem is viewed from a statistical point of view. In those instances in which surgeons have become disappointed with irradiation results and believe that they show a statistical superiority in their accomplishments over those of the radiation therapists, a critical analysis (if such is possible from the reported data) shows that irradiation results are not up to par; this means the cure rates are lower than those which have been attained by the leading radiological institutions which must be considered as the standards for comparison.

It is interesting to note from two studies by Lacassagne[5,6] the importance of adequacy of treatment as expressed in five year cures (Tables II and III).

But even if statistically the superiority or at least equality of radiation therapy for the operable Stages I and II—to our knowledge—so far has not been disproved by any critical analysis on record, the fact remains that now, as fifteen years ago, 20 per cent of Stage I and at least 30 per cent of Stage II cases are not cured by even the most competent and skillful radiation therapists. The

* Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24–29, 1944.

question naturally arises whether these cases represent types of the disease essentially not suitable for radiation therapy (either because of the biological type of the tumor or because of the anatomical location of the spread) and if so, whether possibly some of these lesions could be controlled by radical hysterectomy provided they are recognized prior to treatment—or whether other reasons for these failures can be found which are not evident in a merely statistical evaluation. Taussig's[11] recommendation of an iliac lymphadenectomy in conjunction with irradiation, and Meigs'[7,8] recent resumption of the Wertheim operation for selected cases have again stimulated interest in this problem. It seems that this question cannot be solved by a statistical analysis only but that a careful analysis of the individual unsuccessfully treated cases must complement the statistical data.

TABLE II

CURE RATE IN RELATION TO QUALITY OF TREATMENT (LACASSAGNE, 1929)

Stage	Total Number	Incorrect Treatment Number	Cure Rate All Cases	Cure Rate in Correctly Treated Cases
I	10*	0	7: 9=78%	7: 9=78%
II	20	9	9:30=45%	8:11=72%
III	50	17	25:50=50%	20:33=60%
IV	15	14	1:15= 6%	1: 2=50%

* 1 died of intercurrent disease.

In 1940, for the clarification of our own opinion, we, together with John Wirth, analyzed the failures in cases treated at the Swedish Hospital Tumor Institute between 1935 and 1938.[11] Prompted by the challenge from such an authoritative surgical source as Meigs we have again reviewed the failures in the operable Stages I and II cases treated between 1935 and 1943.

Nineteen cases out of a total of 79 patients Stage I or II are dead at the time of this report or show active disease. The reasons for the failure in these instances are seen in Table V.

TABLE III

IMPROVEMENT IN CURE RATE WITH INCREASING EXPERIENCE (LACASSAGNE, 1932)

	Stage I	Stage II	Stage III
1919–1922	33%	26%	8%
1923–1926	86%	42%	30%

What can we learn from this analysis with regard to the two questions that prompted this investigation?

1. How many, if any, of these patients could have been saved by more adequate radiation therapy?

Three patients with controlled carcinoma died of complications secondary to an intestinal irradiation necrosis, one of them combined with a necrosis of the bladder. Two of these patients of slight build (95 and 105 pounds in weight) received a depth dose through large fields which was sufficient to cause lethal intestinal damage. Furthermore the radon therapy was given during the course of roentgen therapy which we know aggravates the intestinal injury. These patients were treated at a time when the dangers of supervoltage

TABLE IV

FAILURES OF RADIATION THERAPY IN OPERABLE STAGES I AND II TREATED BETWEEN 1935 AND 1943

	Stage I	Symptom Free	Stage II	Symptom Free
1935	1	1	3	2
1936	1	0	2	2
1937	1	0	7	2
1938	2	2	3	2
1939	4	3	2	2
1940	5	4	2	2
1941	4	4	4	3
1942	2	2	15	10
1943	5	4	16	15
Total	25	20	54	40
Failures	5		14	

roentgen therapy were not yet sufficiently understood and appreciated. We have since then learned to avoid such dangerous reactions by more individually adjusting the field size and dose to the size of the patient, by a more adequate timing of the radium application in relation to the course of roentgen therapy and by using radium element instead of radon, permitting a more prolonged treatment with uniform dosage rate. As can be seen from Table v no such injuries have occurred in the second observation series since these changes, based on the previous experience, have been introduced. It is obviously this kind of avoidable intestinal injury that Meigs observed in 46 cases which caused his statement that "there will be less damage to the bowel if surgery is undertaken." *It must be clearly understood that in later stages of the disease more severe intestinal reactions sometimes cannot be avoided if a permanent cure of the cancer is attempted. But for the early stages here under discussion severe intestinal reactions must today be considered as due to faulty treatment.*

Of the 4 patients with pelvic complications (Group 4, Table v) we believe that the one who died of a sepsis could possibly have been saved by a more judicious conduct of therapy. This was a Stage II carcinoma treated immediately post partum with an associated pelvic cellulitis before treatment was begun. The infection improved under external roentgen therapy but the intracervical radium therapy was given too soon, assuming the infection was controlled. In spite of all efforts the patient died of pelvic peritonitis.

Whether the patient who developed a pyometria following treatment and died of a pelvic abscess in spite of repeated drainage could be saved today is open to discussion.

The 2 other patients in this group were treated we believe as well as was possible and death was probably unavoidable.

The 2 patients in the sixth group we think might possibly have been saved by a better distribution of the dose in space.

TABLE V

ANALYSIS OF FAILURES

	1935–1938	1939–1943	1935–1943
1. Treatment incomplete	1 insanity	1 mental attitude	2
2. Distant metastases	1 pulmonary		1
3. Extrapelvic complications; pelvic disease controlled	1 cardiac	1 nephritis 1 meningitis p. otitis	3
4. Pelvic complication	1 pyometria 1 cancer with post partum sepsis	1 pregnancy 1 second pelvic care	4
5. Death from sequelae of treatment; disease controlled	2 intestinal obstruction 1 rectal and vaginal necrosis		3
6. Treatment errors, disease uncontrolled		2 low external dose	2
7. Unexplained	1	3	4

CASE 1. G. O., aged thirty. June, 1942. Weight 134 lb. Anteroposterior pelvic diameter 23 cm., circumference 91 cm. Intermenstrual

bleeding for three months. Two weeks ago severe hemorrhage. Enlarged cervix with tumor breaking through anterior lip. Endocervical carcinoma, Stage II. Considerable infection. Microscopic examination showed a very anaplastic squamous carcinoma.

External roentgen irradiation, 9,700 r in thirty-three treatment days, 800 kv.; vaginal roentgen irradiation (after initial external roentgen irradiation of 2,600 r for infection), 7,465 r in twelve days. Radium treatment, 4,040 mg-hr. (2,020 mg-hr. cervical tandem, 2,020 mg-hr. vaginal ovoids). External roentgen treatment given through one anterior medial 10 by 14 cm. field (3,350 r), one sacral medial field (1,200 r) and one right and left sacroiliac field. No anterolateral suprapubic fields were used and therefore the parametrial dose was insufficient while the central dose was too high, considering the intravaginal application. Repeated loose bowel movements throughout treatment, probably due to the initial central dose of 2,600 r in eight days, given because of the infection. On account of this irritation, the total external roentgen dose was too low.

September, 1942, two normal bowel movements daily. Cervix normal on palpation, injected; rectovaginal septum soft. October, 1942, and January, 1943, findings unchanged. Pelvis soft; no necrosis. March, 1943, pain in left leg. Small hard induration in left parametrium, interpreted as fibrosis because of high central dose. May, 1943, edema left leg. Tender mass felt with difficulty high up in left parametrium by rectal examination. September, 1943, uremia. October, 1943, patient died.

Autopsy showed a large mass in the left parametrium with complete ureteral obstruction; smaller mass in right parametrium with ureteral obstruction and dilatation. Microscopic examination showed carcinoma in both parametria.

As can be seen, the lateral portions of the parametria received an insufficient dose because the treatment was concentrated to the center in view of the endocervical type of the disease. Considering the anaplastic type of the tumor a more complete coverage of the parametria would have been indicated.

Case II. A. N., aged thirty-one. May, 1943. Weight 140 lb. Anteroposterior pelvic diameter 22 cm. Circumference 88 cm. For six weeks vaginal discharge with pain in right lower quadrant. No intermenstrual bleeding. She consulted her physician on account of the vaginal discharge. Biopsy showed an epidermoid carcinoma with only slight degree of differentiation. Profuse vaginal discharge. Cervix showed a scar extending from external os on right toward the right vaginal wall. Tenderness on palpation of parametria, particularly on the right. Carcinoma of cervix, presumably Stage I, with parametritis. Treatment started with roentgen radiation. Total dose 8,950 r in thirty days, using 400 kv. Treatment was then discontinued in order to permit higher radium dose. Cervical tandem 3,960 mg-hr., vaginal ovoids 4,650 mg-hr. In September and November, 1943, cervix of normal size. Pelvis soft on rectal examination. In December, 1943, pain in anterior circumference of right thigh. Pelvis soft. February, 1944, progressing pain and edema of right leg. Mass palpable in right parametrium. Because of previous pelvic infection there was a question of pelvic abscess or recurrent disease. Intravenous urograms showed poor function of right kidney with marked caliectasis. Under observation no marked change in local findings but progression of pain. Since abscess could not be excluded with certainty and aspiration through the vagina was negative, exploration was done which showed a hard carcinomatous mass in the right pelvis. Patient died in June, 1944.

In this case again the parametrial dose was undoubtedly too low because this was considered as a Stage I carcinoma. This was certainly poor judgment. Either roentgen therapy should have been given only in an amount to combat the infection or it should have been carried to a presumably adequate dose, in this case at least 12,000 r.

There remain 4 patients listed as unexplained failures. They all died of parametrial recurrence.

Case III. H. S., aged fifty-three. November, 1935. History of six months' spotting. Stage II. Extension into vaults of the vagina. No parametrial induration. Epidermoid carcinoma, Grade 3. Radium treatment was given consisting of 3,500 mc. (2,500 mc. intrauterine, 1,000 mc. vaginal). Roentgen treatment was given with 800 kv., total dosage of 13,500 r. In Sep-

tember, 1936, the cervix was entirely healed; there were pain and edema of the left leg; parametrial thickening. The patient died in December, 1937.

Case iv. V. B., aged forty. November, 1942. Weight 157 lb. Regular periods until two months ago; since then intermittent flow. Posterior lip replaced by large hard ulceration. Vaults, fornices, parametria soft. Stage ii. Microscopic examination showed squamous carcinoma, Grade 3. Radium treatment consisted of 7,940 mg-hr. (3,900 mg-hr. vaginal ovoids; 4,040 mg-hr. cervical tandem); roentgen treatment 11,100 r in fifty-nine days using 800 kv. Cervical radium after initial 3,800 r because canal could not be entered at first. April, 1943, cervix small, smooth, soft, pelvis soft. September, 1943, pain in right leg. Hard induration in right paravaginal and parametrial area, extending to pelvic brim. Non-functioning right kidney. October, 1943, intolerable urinary frequency, urinary hemorrhage. Cystoscopically large ulcerated tumefaction on right trigonal area, covering right ureteral orifice. This tumefaction, on palpation, was in direct connection with palpable parametrial mass. The patient died.

Case v. A.C., aged thirty-six. June, 1942. Weight 192 lb. Anteroposterior pelvic diameter 24 cm.; circumference 112 cm. Two years ago occasional spotting after intercourse; last two months more marked bleeding. Large ulceration of posterior lip, granular induration of anterior lip. Cervix movable. No infiltration in fornices, vaults or parametria. Stage ii. Microscopic examination showed squamous carcinoma, Grade 3. Radium treatment, 11,610 mg-hr. in twenty-seven days (4,040 mg-hr. vaginal colpostat, 4,490 mg-hr. uterine tandem, 3,080 vaginal ovoids). Roentgen treatment, 13,400 r in forty-four days using 800 kv. October, 1942, cervix soft and smooth. Pelvis soft. February, 1943, pain in left leg. Edema of left leg. Cervix small and smooth; apparently cervical lesion controlled. Parametria on palpation soft. July, 1943, frozen pelvis, block of left ureter. Patient died of uremia.

Case vi. F.D., aged thirty-two. September, 1942. Weight 124 lb. Anteroposteior pelvic diameter 18 cm., circumference 92 cm. Regular periods. For one week continuous intermenstrual bleeding. Had never had intermenstrual bleeding or spotting. Large hard cervix. Slight invasion of left fornix. Parametria soft. Stage ii (ii–iii?). Microscopic examination showed anaplastic squamous carcinoma with infection. Radium treatment, 9,000 mg-hr. (4,000 mg-hr. intrauterine, 5,000 mg-hr. vaginal). Roentgen treatment, 11,650 r in forty-three days, using 800 kv. March, 1943, cervix healed. May, 1943, rectal urgency, thickening of rectovaginal septum, induration with central ulcer in anterior rectal wall, 2 cm. necrosis in left vaginal fornix. September, 1943, pain in left leg. Vaginal necrosis healed, induration of rectovaginal septum disappeared, moderate thickening of both parametria. October, 1943, cervix completely effaced, stenosis of upper vaginal dome, induration in left parametrium to pelvic brim. Left ureteral obstruction. February, 1944, induration of both parametria, beginning uremia. Patient died in March, 1944, of uremia. On autopsy large pelvic mass, frozen pelvis, both ureters dilated to thickness of a thumb.

It seems to us that in these 4 cases the treatment received must be considered adequate according to today's standards. They therefore seem to represent unavoidable irradiation failures.

2. The second question then arises: *Could any of these patients have been saved if they had been treated by radical hysterectomy instead of irradiation?*

Meigs[7] lists the following 5 main reasons which have led him to the "introduction of an old and formidable operation into the treatment of cervical cancer" in his clinic.

1. If the cervix has been removed there is no chance for a recurrence in it.
2. If the cervix has been removed no cervical cancer can regrow in it as a re-occurrence.
3. Certain cancers of the cervix are radioresistant—(a fact proved at the Pondville Hospital where multiple biopsies are performed at the time the X-ray and radium treatment are being carried out).
4. There will be less damage to the bowel if surgery is undertaken. Lately 46 cases of serious bowel injury have been found in our clinics.
5. From the work of both Bonney and Taussig it is obvious that patients with lymph node metastases can be cured by surgery in some instances and the author

believes that it is not possible to cure with radiation cancer in lymph nodes deep in the pelvis.

It does not seem that the reasons listed under 1, 2, and 4 are valid.

That severe bowel reactions for the stages here under discussion can be avoided has already been discussed. A recurrence of an uncontrolled epidermoid cancer or a regrowth of a new cancer in the cervix itself after adequate irradiation is extremely rare. In patients with Stage I and II cancer who died of uncontrolled disease, the cervical lesion itself is almost always controlled. *None of the failures in this series was due to uncontrolled or recurring cancer in the cervix itself.* In our total series of 153 cases of all stages treated since 1935 we have observed one regrowth in the cervix itself after four years' freedom from demonstrable disease in a Stage III carcinoma in a patient seventy years of age.

Nevertheless it does occur and in cases of uncontrolled disease in the cervix itself in spite of adequate therapy this failure must probably be explained by an unusual radioresistance of the tumor as mentioned by Meigs as his third reason in favor of surgery. To quote Lacassagne: "For a certain kind of cell no lethal dose exists; . . . lesions in similar tissues, exposed to the same conditions of homogeneous irradiation do not always show similar results. Only this is definite that there exists no certainty either as to the probability of survival of tissues or a certitude of their destruction by any determined irradiation."

The observation of the cervix itself as the source of failure in adequately treated cases of true epidermoid carcinoma is, however, so rare that it should not enter into an appraisal of clinical probabilities deciding between surgery and radiation therapy. *Active disease in the cervix itself as a cause of failure due to the radioresistance of the tumor should be accepted only after careful analysis of the histopathological findings and of the irradiation record of the individual case.* With the migration to the West Coast, we have seen during the last two years a number of patients treated in different parts of the country, and we have sometimes been impressed by the inadequacy of the treatment they have received. We do not think that a radium dose below about 8,000 mg-hr. (with adequate distribution in space and time) can be considered adequate even if one occasionally seems to obtain results with less. We have also at times seen that interstitial irradiation is still used. With this technique naturally a homogeneous irradiation with a lethal dose throughout the lesion is very difficult to accomplish and problematic and the finding of viable cancer cells in some areas of the cervix, or a regrowth, is not surprising. But this cannot be explained by an unusual radioresistance of the particular tumor. In such cases an improvement of the irradiation technique is preferable to return to radical surgery.

Meigs', as well as Taussig's valid argument for surgery, we find in Meigs' last reason "that it is not possible to cure with radiation cancer in lymph nodes deep in the pelvis." Lymph node metastases from epidermoid carcinoma anywhere are almost never controlled by external irradiation, even in much more accessible areas such as the oral cavity. For this reason surgical dissection has unquestionable preference in the management of the lymphatic area in this type of carcinoma. For the pelvic nodes the situation is even less favorable. In a previous report of the authors with Parker before the Radiological Society in 1940,[2] it was shown that, according to Parker's careful measurements, the dose delivered with 800 kv. roentgen rays using 3,500 r (measured on the skin) through each of two anterior and two posterior 10 by 14 cm. fields to a point of the soft tissue inner pelvic wall at about the mid-attachment of the broad ligaments reaches approximately only 2,600 r in a large pelvis (26 cm. diameter), 3,000 r in a medium pelvis (22–24 cm.) and 3,500 r in a small pelvis (20 cm.). The isodose curve computed for the combined contribution of 8,000 mg-hr. radium with roentgen rays as described showed that at

this same point in small pelves only a total dose of 4,500 r is reached. This dose seems too small and from our experience with other epidermoid lymph node metastases we can hardly expect a sterilization of the peripheral pelvic nodes. A further increase of this dose in an amount necessary to expect even a marked fibrosis of those nodes with prolonged retardation of their growth is, as experience has shown, not possible without intolerable damage to the pelvic vascular connective tissues and severe intestinal reactions.

It seems from clinical observation and from analogies that radiation therapy can control pelvic disease beyond the cervix if it represents a diffuse direct invasion through the lymphatics of the broad ligament but not disease in the lymph nodes. (We are of course never certain how much of a palpable pelvic infiltration is due to true cancerous invasion, how much to infection, and how much to fibroblastic response of the tissue to progressing cancer.) Therefore, apparently extensive disease of Stage III can be controlled in a certain percentage of cases while apparently less advanced stages in which the involvement of peripheral pelvic nodes cannot be demonstrated by palpation develop parametrial disease from these uncontrolled lymph nodes. At least 2 of our 4 cases listed as unexplained failures probably fall in this group (Cases IV and V). This is suggested by the fact that pain and edema of the leg preceded the demonstrable pelvic induration by many weeks, probably indicating that the recurrence started from a higher node and became palpable only after the induration was in reach of the examining finger. The other cases probably belong in the same group but the appearance of demonstrable induration coincided with the appearance of pain.

Admitting, then, that there is a small group of cases for which a permanent cure with our present methods of radiation therapy is unlikely but for which, a priori, a better surgical chance could be expected, *the question arises as to their actual chances if surgery is used.*

Two procedures are available. Taussig recommends for Stage II cases a combination of radiation therapy to the cervix and its immediate neighborhood in conjunction with iliac lymphadenectomy. There are two objections to this type of therapy. One is the fact that no attempt is made to remove the lymph nodes around the lower portion of the ureters because this would make the operation considerably more complicated and risky, and because it is assumed that the irradiation should take care of the lymphatics in this area. While it is true that the dose in this area is considerably higher than the one in the peripheral portions of the pelvis, mainly because of the addition of the radium dose, it still remains questionable whether a complete sterilization is likely. This might be possible for some lymph nodes in cases of less differentiated carcinomas. But in these less differentiated carcinomas, we have to expect a more generalized spread through the lymphatics and surgery would not take care of this. On the other hand, and this is the second objection, every procedure where radiation therapy and surgery are applied to the same field is bound to affect either procedure to a certain degree. We believe that after intensive radiation therapy by a combination of a maximal radium and a maximal roentgen-ray dose, a procedure such as iliac lymphadenectomy carries considerable risk. This method was patterned after the combined treatment, for instance, of oral carcinomas, where radiation therapy to the primary lesion together with a block dissection of the lymphatics is unquestionably the procedure of choice. But surgery here is applied to an area which has not received any irradiation, and furthermore a complete block removal is done, while such is not the case in the type of operation recommended by Taussig.

For these two reasons, it seems questionable whether viewed statistically the procedure will accomplish as much as either

radical hysterectomy or intensive radiation therapy alone, although it is admitted that occasional cases in which only the more peripheral pelvic nodes are involved may be saved, while they would not be controlled by irradiation. The statistical evaluation of Taussig's results in which he computes a 68 per cent greater salvage than by irradiation alone seems erroneous. His five year survival rate with the combined procedure is 38.6 per cent against 22.9 per cent in Stage II cases treated by irradiation alone. By analyzing the irradiation procedure used for comparison with his, we find that the irradiation applied in this series has been greatly improved throughout the years, implicitly admitting the inadequacy of radiation therapy in former years. Yet these earlier cases are apparently included in the material for comparison. This probably explains the low survival rate of 22.9 per cent of the cases treated by irradiation alone as compared with the possible survival rate of 40 to 60 per cent for Stage II accomplished elsewhere. As has been seen, a survival rate of 70 per cent can be attained in correctly irradiated cases of Stage II (Table II).

Taussig found cancerous involvement of the removed glands in 26.8 per cent of 175 Stage II cases operated upon. Twenty-one per cent of those with demonstrated metastases showed a five year cure rate. In other words, the operation was found to be necessary in 1 out of 4 in whom it was performed, and 1 out of 5 of those in whom it was necessary was cured. This means 1 out of 20 patients in whom the operation was done was saved by the procedure. Nineteen out of 20 patients were not benefited by the procedure and in all likelihood some of these could have been salvaged by a more radical radiation therapy applied without the allowance for the anticipated later surgery. The situation, of course, would be different if it were possible to recognize these cases before any treatment is instituted. As far as our 4 patients under discussion are concerned, each one would have had a chance of 1 to 5 to be salvaged, but I doubt that after the intensive irradiation they received the procedure would have been feasible without grave complications.

It seems quite logical that if surgery is done it should be in the form of the radical Wertheim operation without considering radiation therapy. Meigs, prompted by his disappointment in radiation therapy, has recently revived this classical procedure. He has operated upon 65 cases without a single death. The improvement of modern surgery during the last decade, particularly in combating shock and infection, will certainly contribute to the reduction of the primary mortality. Bonney,[1] probably one of the best gynecological surgeons who has done this operation on a large scale, has an average primary mortality of 10 per cent, but it seems that he accepts for the operation cases more advanced than those selected by Meigs, as indicated by the findings of actual cancerous node involvement in 17 per cent in Meigs' group as against 40 per cent in Bonney's group.

Of the 65 patients operated upon by Meigs[9] 53 had no cancerous lymph node involvement. Two of these are dead. In 12 cases positive lymph nodes were found. Three of these are dead. Interpreting these results, we can say that so far (provided that the still living patients will remain alive) out of a group of 65 patients, 9 were saved who would not have been saved by irradiation, granting that radiation therapy cannot sterilize lymph node metastases. *This means 20 patients have to be subjected to this radical operation in order to save 3 that could not have been saved otherwise.*

Meigs' requirements are very strict. Ideally, the patient should be thin, young, in good health, and have an early cancer. Under these requirements, it seems that out of the 4 cases in our group which were not saved by radiation therapy only 1 (Case IV) would have been acceptable. Case V, a patient weighing 192 pounds and with a pelvic diameter of 24 cm., would have been refused on account of adiposity. Case II

had an accompanying parametrial infection prior to treatment. Case III had a duration of symptoms of six months with a beginning extension into the vaults and the case probably would not have been considered by him as early carcinoma. But it is just for the cases in the more advanced Stage II in which increased size of the disease and increased duration, the likelihood of peripheral lymph node involvement is higher and therefore the chances of irradiation cure lower, where surgical help may be considered, and in this group we know from extensive studies that the primary operative risk rises and the cure rate decreases. The 4 cases in our series for which in retrospect we might have considered surgery were well developed Stage II. No Stage I was found in this group.

"Very early carcinomas" (early Stage I) have an excellent chance of permanent cure by radium only with one week hospitalization and no subsequent morbidity due to the treatment itself. For this type of case a procedure of the magnitude of the Wertheim operation seems not to be necessary. In recognition of this fact, Taussig has not suggested his combined procedure for these cases but only for Stage II cases.

Concluding, we must admit that there is a group of cases of epidermoid carcinoma of the cervix with peripheral lymph node involvement in the pelvis in which, on the basis of clinical experience and conclusions from analogies, radiation therapy apparently will not accomplish a cure and in which theoretically surgery would be more promising. In our own series 4 cases out of 79 belong in this group. Three of these cases would not have been accepted for surgery according to Meigs' rigid standards. In Meigs' own series 9 patients belong in this group out of 65 on whom he operated. This means 3 out of 20 would be saved while 17 would be subjected to unnecessary surgery.

Whether under these circumstances the indication for the Wertheim operation is considered acceptable is of course a matter of personal opinion.

Since it is impossible to recognize these cases prior to treatment, it is most likely that from a statistical point of view the actual survival rate by surgery would be smaller than if radical radiation therapy were instituted. The survey of our own material has shown that more cases were not controlled by irradiation because of some avoidable inadequacies of treatment than would have been saved by surgery of cases essentially unsuitable for irradiation. The analysis of Lacassagne's failures suggests the same conclusion. We are forced to admit that improvement of radiation therapy by more careful attention to details of technique, by the elimination of inadequate procedures of the past and by the careful adaptation of the procedure to the individual requirements will probably save more patients than a return to surgery. But we should be grateful to the surgeons for awakening us from our satisfaction with past accomplishments and for stimulating our desire for improvement.

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DISCUSSION

Dr. Charles L. Martin, Dallas, Texas. Drs. Buschke and Cantril have raised a question in which gynecologists are much interested at the present time. Should favorable Stage II cases of cancer of the cervix be subjected to radical surgery? Meigs, of Boston, has revived the interest of surgeons in this problem by performing the Wertheim operation on a series of 65 such patients, with no immediate mortality, whereas, in bygone days the surgical mortality in various clinics varied from 15 to 30 per cent. He does the operation in an effort to remove pelvic nodes which may contain metastases.

Our experience with neck dissections has taught us that success depends on the block removal of all the lymphatics and nodes in a given area. The block removal of the lymphatics on either side of the uterus traversed by the delicate ureters is a very difficult procedure, and even though Meigs' patients survived the severe shock of the operation, many of them had serious postoperative complications, principally ureteral damage. Such sequelae may be justified if five year statistics prove that the salvage is markedly improved by such a radical procedure, but I feel that we should not swing back to radical surgery until convincing statistics are available. It seems unfortunate that the publicity given Meigs' work has induced many surgeons, who do not possess his skill, to resume the surgical care of all patients with cancer of the cervix.

One of his reasons for using the operative procedure was his observation that many of his own cases, receiving radiation therapy, developed serious intestinal damage. Results published by our own clinic, as well as those of Lenz, and others, indicate that good results can be obtained without such sequelae.

Dr. Juan A. del Regato, Columbia, Missouri. Drs. Buschke and Cantril must be congratulated for their very careful analysis and for their timely warning.

Ten years ago I participated in what we thought was the closing chapter of this controversy of surgery versus radiotherapy in early carcinoma of the cervix. I refer to the memorable session of the French Academy of Medicine and the argument between Regaud and J. L. Faure. It appeared then obvious that radiotherapy, properly done, was superior to the Wertheim operation in the treatment of early carcinomas of the cervix.

This controversy has been recently revived in this country by the surgeons as well as by the radiotherapists who were not satisfied with their own results. Worthy of comment is the report by Dr. Jones of the Kelly Clinic in Baltimore who reported a very interesting experiment. In his clinic the very early carcinomas of the cervix, Stage I, were operated upon and the more advanced Stage I cases were treated with radiotherapy. After a number of years the percentage of results for those treated with radiotherapy was superior to that obtained with surgery although the choice of cases was favorable to surgery.

We must not lose our sense of proportion in this controversy. The number of cases to which this is limited is very small. Healy reported in the late 1920's a classification of 1,500 cases of carcinoma of the cervix, only 12.5 per cent of which were operable. We have now a classification of carcinomas in four stages which corresponds better to the prognosis of the different cases. This classification gives an average of 10 to 12 per cent of the Stage I cases.

It remains that at best only 80 per cent of the carcinomas of the cervix, Stage I, are cured by irradiation and it is interesting to analyze whether the 20 per cent of failures could be reduced.

Local recurrences of carcinomas of the cervix are the exception. Few carcinomas of the cervix are actually resistant to proper treatment. Most post-irradiation recurrences occur in the parametrium. I agree with Drs. Buscke and Cantril that the technique of treatment chosen is most important and insufficient doses will of course give local recurrences. Interstitial irradiation will be the cause of radionecrotic damage to the

bowel and other structures which may account for the loss of the patient.

As far as the proportion of lymph node involvement in early carcinoma of the cervix is concerned, it must be stated that many authors have reported as metastatic implants the presence of adenoid epithelial structures in the iliac nodes. This is obviously an error. Those epithelial structures are only important if they present an epidermoid differentiation, or definite evidence of malignancy.

When a carcinoma of the cervix is irradiated and a surgical excision follows immediately, the presence of carcinoma in the removed specimen is no proof of radiotherapeutic failure. This will also be the case in a basal cell carcinoma of the skin which would be excised shortly after radiotherapy. The latent period between the administration of radiation treatment and the complete disappearance of the tumor increases with the differentiation of the tumor.

The argument of late recurrences in carcinoma of the cervix is not strong. Regaud analyzed a series of 500 cases which had recurred after irradiation and only 1.5 per cent of them had recurred after five years.

The main argument remains that of losing the patient through radionecrotic effects on the bowel and other normal structures. One cannot consider the percentage of such accidents on an over-all group to be of significance in the restricted group of early carcinomas of the cervix.

In closing, I believe that if a comparison of surgical and radiotherapeutic results is to be done again, the good surgical results should be compared with the good radiotherapeutic results.

Dr. Buschke (closing). The question of dosage is of course always unsatisfactory in a discussion unless one can qualify the details of the technique used. With regard to a question as to our roentgen-ray doses, I would like to integrate the consideration of roentgen-ray doses in the entire treatment schedule and therefore discuss it together with the details of our radium technique.

The doses mentioned are planned on the basis of what is now more generally known as the French technique. This means the radium is given for a period of approximately ten days with the dose divided: 4,000 mg-hr. in the cervical canal and 4,000 mg-hr. in the vaginal vault. The roentgen treatment is given through two straight anteroposterior and two straight posteroanterior fields. This means the beam is not converging toward the cervix because we feel that the adequate radium dose has taken care of the primary lesion. I think that this application of straight fields with the protection of a small central area is one of the reasons why our intestinal reactions are not as marked as they apparently sometimes are observed by others. The dose given to each of these four fields is approximately 3,000 to 3,500 r, measured on the skin, giving a total dose of 12,000 to 14,000 r, depending on the patient, delivered in approximately six weeks.

Now, if I say this is a standard technique, this should not be misinterpreted because this basic procedure is subject to considerable variation depending on the individual case, and I do not think that we treat more than 2 out of 10 patients with this actual standard procedure.

The individualization applies to roentgen as well as to the radium therapy and to their time relationship. We believe that the attention to minute details and careful adaptation of the technique to the individual requirements are necessary to avoid dangerous reactions and yet to push the dose to the limit of tissue tolerance. The radium containers are inserted under anesthesia if the patient is apprehensive or if a better relaxation of the vagina under anesthesia is anticipated. With less apprehensive patients and a larger vagina, sometimes the application of vaginal applicators in knee chest position is preferable because in this way the distance between the radium carrier and the rectal mucosa can be increased.

With such attention to details, we have given doses up to 12,000 mg-hr., but I certainly would not recommend this as a standard procedure. However, I believe there is no standard procedure. Certainly a dose of 8,000 mg-hr. would be too high if, for instance, the entire treatment were given in three days. We purposely use applicators with a low radium content. We do not have more than 40 mg. or at the very most 50 mg. in the tandem, and 20 or 25 mg. at the most in each of the vaginal applicators. This content depends also partly on the size of applicators that can be introduced. In this way we deliver the required dose in approximately 100 hours, distributing the entire treatment with radium over about ten days. More frequently, we permit an interval of

about eight to ten days between the vaginal and cervical applications. Again depending on the anatomical findings, we might increase the vaginal dose and correspondingly decrease the cervical dose, or vice versa. Likewise the roentgen procedure is adapted to the individual requirements as indicated by the clinical findings. The dose over one parametrium may be increased with a corresponding adjustment of the total dose. In other cases again, particularly those with vaginal extension, the beam might be convergent toward the vagina with corresponding adjustment of the radium dose to allow for the increased rectal reaction.

In short, we attempt to adjust the technique as carefully as possible to the individual requirements. It goes without saying that no detail of this procedure (including the daily placing of the patient for roentgen therapy) is executed by anyone but the radiotherapist who has the patient under his permanent care. No division of efforts is permitted.

With regard to the question of whether the Taussig lymphadenectomy gives any additional advantage, I refer to the discussion in the printed paper as submitted for publication. Time does not permit me to go into these details here.

A SLIDE RULE FOR DETERMINATION OF DOSAGE FROM LINEAR RADIUM APPLICATORS

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IN SUPERFICIAL or interstitial radium therapy it is sometimes necessary to determine the dose delivered by a single needle or tube. In interstitial treatments of very small lesions the dose must be determined from the contributions of individual needles at the point of interest. For instance, a technique for the treatment of the lips which is extensively used at this Hospital is the implantation of two parallel needles of sufficient length which are inserted about 1 cm. apart. The dose delivered to the lesion can then be related to the dose at the center between the needles.

The point at which the dose is to be determined is generally situated opposite the center or active end of a needle. For other locations the needle can always be divided into two parts so that the point considered lies opposite an active end of each and the dose is then composed of two contributions from each needle. For a linear applicator the effect of oblique filtration is not negligible and depends on the ratio of the distance from the needle to its active length. Besides, the needle can be filled with radium or with radon and the relatively quick decay of the latter must be allowed for.

Several methods are available[1,3,4,5,6] to determine the dose delivered by a filtered linear source. They are based on the use of different tables or diagrams and all require some additional though not difficult calculations. A nomogram that could completely represent the relation between the quantities involved would be very complex because of the great number of variables and also because the filtration effect is not independent of other variables. It was found possible, however, to design a multiple slide rule which not only represents the relation between all variables but which is also simple to use. In addition, it permits quick solution of numerous other problems which occur in dosage calculations.

The instrument is based on Sievert's formula and tables[5,6] and is shown in Figure 1. The essential theory of it is given in the appendix. The quantities involved are represented on scales, and by moving the slides these can take up any position relative to each other. All slides must be set so that those divisions corresponding to the problem at hand are opposite to each other on adjacent scales. Where transfer marks only are provided these must be used for setting the slide. The range of all scales is sufficient to cover any case that may occur under normal therapeutic conditions.

Starting from the top, the first scale which is fixed to the main body of the instrument refers to the activity of a needle in milligrams of radium. If radon is used the figures give the number of initial millicuries. The first slide is set under it; it carries the two necessary time scales for radium and radon respectively, and also an upper and lower transfer mark. The upper (radium) scale must be used in conjunction with the lower mark, and vice versa. The next slide carries identical scales on its upper and lower border and shows active length. There are two notations: the ordinary figures must be used if the dose is determined at a point opposite the center of the needle, while the figures in brackets refer to points opposite the active end.* The following slide has only one scale for distance from the needle axis. On its lower border a transfer mark leads to a line system without notation. It is only necessary to follow the lines from the transfer mark to the lower border and set the next slide

* The dose opposite the center of a needle equals the dose opposite the active end of another needle of same total radium content but one-half its active length.

under the point thus obtained. The part carrying this line system is rigidly connected with the active length scale and thus forms a holder for the intermediate distance scale. The principle of extending one of the slides into a complete slide rule permitted the solution of the problem that one of the factors contributing to the dose was itself a function of several variables. This auxiliary slide rule computes that function and the result is linked with the main slide rule over the transfer line system. Before discussing the next slide which refers to filtration we assume that it is omitted altogether and go straight on to the last scale which again is fixed to the main body of the instrument and gives the dose in roentgens. The instrument described so far (omitting the filtration scale) represents the relation between the variables for a fixed filtration of 0.8 mm. of platinum. For other filtrations a correction factor has to be applied which, as mentioned before, also depends on the ratio of distance to active length. The correction is comparatively small and it is possible to use a constant correction factor within a limited range of the ratio without introducing an appreciable error. The whole range of all possible ratios was divided into a number of such sections and a complete filtration scale was provided for each. These scales include zero filtration but it should be kept in mind that the gamma-ray dose only is determined, while for extremely low filtrations a great amount of beta radiation may also be present; the dosage contribution of the latter is not considered. The filtration effects have been calculated on the assumption of a mean absorption coefficient for platinum of 2.0 $cm.^{-1}$ as given by Sievert.[5] In view of a recent paper by Mayneord and Honeyburne[3] a value of 1.5 $cm.^{-1}$ might be more accurate although the difference for medium filtrations is very small indeed. The filtration scales which are very short are arranged side by side on the slide omitted from the discussion before. They are marked *A*, *B*, *C*, . . . *G* respectively. The upper border of the transfer line system is subdivided into corresponding sections *A*, *B*, *C*, . . . *G* according to the ratios of distance to active length. The transfer mark of the distance slide is also used to indicate which filtration scale must be used.

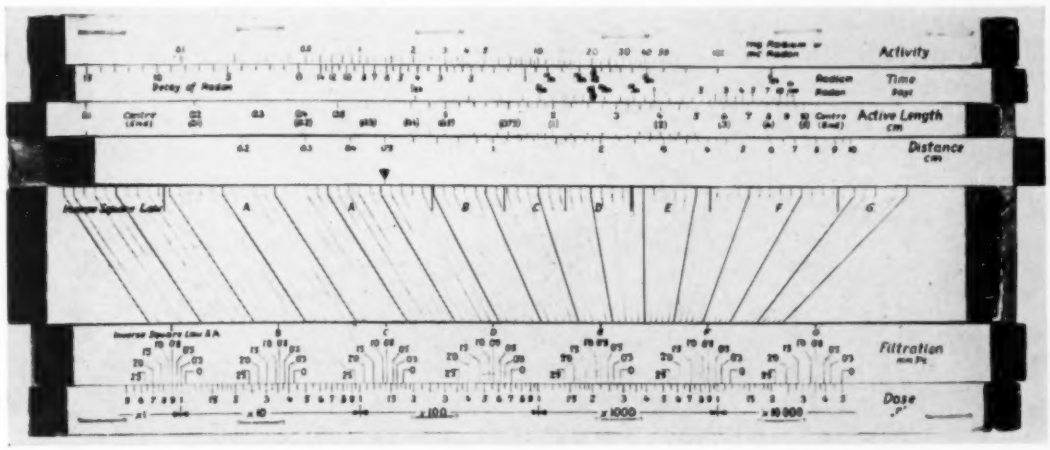

Fig. 1. Photograph of the slide rule (for description see text).

For distances greatly exceeding the active length the transfer line system would have to extend very far to the left. In these cases, however (distance greater than three times the active length), the dose does for practical purposes not depend anymore on active length and can be worked out according to the inverse square law for point sources. A section marked "Inverse Square

Law" has therefore been added within which any selected active length will give the same result. In this section all transfer lines have become parallel. A change of the active length will cause the active length scale and with it the transfer line system to be moved in one direction while the distance scale is moved by the same amount in the opposite direction. Because of the parallelism of the line system the effects of these two movements will just cancel each other so that the same result is obtained whatever active length may be chosen. In this way it was possible to reduce the extent of the line system to that of the other scales.

The dose in roentgens was computed on the assumption that the specific emission of gamma rays from radium was 8.0 r/mg-hr. at 1 cm. distance from a point source filtered by 0.5 mm. Pt. So far, no general agreement about this figure has been reached but other values could easily be allowed for, e.g., by a slight shift of the transfer marks on the filtration slide.

The sequence of slide settings can be chosen at will. That means that any quantity can be determined if all the others are known. Furthermore, any setting of two adjacent scales gives a whole series of corresponding values which will yield the same result if all other factors are kept constant, and it is thus possible to solve many interesting part-problems. If the quantities one is interested in are not on adjacent scales, any arbitrary values on the intermediate scales can be chosen, as long as they are kept constant. Sometimes it may be more convenient to alter the succession of slides which can be introduced even in reversed direction without affecting the result. In the following, a few problems are stated which all can thus be solved in a few seconds: A radon implant gives the required dose in, say, 7 days; how much radon must be used to give the same dose in 5 days?—If a treatment was planned for radium, how much radon would be required to give the same dose in the same time?—Variation of dose from a given needle with distance—Relation between active length and dose, other factors remaining constant, etc.

The instrument permits immediate determination of the dose at points opposite the center and opposite the active end of a needle. Usually, knowledge of the dose at these points is quite sufficient, but the dose at other points can be worked out by the following method. The needle is divided into two parts where the dividing point is opposite the point considered. For each part, the dose can be worked out separately and the total dose is simply the sum of the two contributions. For points outside the active ends, a similar difference method can be applied which, however, is apt to become highly inaccurate when the difference of the contributions becomes small compared with the contributions themselves.

Sometimes a radon applicator cannot be used at the specified time and if the delay is considerable, loss of strength due to decay must be allowed for. For such calculations a short scale marked "Decay of Radon" was added at the upper border of the first slide (treatment time). If the zero point of this scale is set under the number of initial millicuries of radon, then the amount remaining after a certain time can be read off opposite the corresponding scale division.

A few details on the construction of the slide rule might be of interest. The scales were drawn at a somewhat increased size and then photographically reduced to final size. (The slide rule is 10 inches long.) The negative was taken with a commercial reproduction camera* and ordinary contact prints were obtained from it. The prints were kept flat during drying and no difficulties due to irregular shrinking of the paper were encountered. The body of the slide rule was made up of thick cardboard as used for packing of roentgen films and glued together with office paste. To prevent the slides from falling out, the top was covered with a sheet of clear roentgen film base

* The author is indebted to Mr. V. Veitch for the preparation of this negative.

attached by a number of wire staples. The scales were protected by two coatings of celluloid varnish and the rest of the cardboard surface was similarly treated with shellac.

The accuracy obtainable with this rather crude model is of the order of a few per cent which is quite sufficient for clinical work. After several years of extensive use, the instrument is still in perfect condition.

APPENDIX

While graphical representation of the relation between two or more variables is widely used, slide rules designed for one particular problem are relatively rarely found. The reason probably is that the making of a slide rule involves a good deal more work than an ordinary nomogram and it cannot be as easily reproduced as the latter. On the other hand, a nomogram for more than three variables can become very confusing while a slide rule does not lose its clearness when the number of variables is increased. The extended slide rule principle used will now be described in general form and then applied to the special problem.

Figure 2 illustrates the slide rule principle for relations between four variables p, q, r and s. There are four scales, one for each variable, which are drawn in such a way that the distance of a point denoted by p from the scale origin o is given by $P(p)$ where P is some function of p. The same applies to the other variables. From Figure 2 the basic relation can be read off immediately

$$S(s)=P(p)-\mathcal{Q}(q)+R(r). \qquad (1)$$

Any relation between four variables that can be brought into the form of (1) is therefore suitable for representation by such a slide rule. Naturally, this also includes relations of the form $Y(y)=A(a)\cdot B(b)\cdot C(c)$ because they can be reduced to form (1) by taking the logarithm of the whole equation and then putting log $A=P$, etc. It is very easy to extend the number of variables by adding one or more slides, carrying the necessary scales. Generally, this type of slide rule is suitable to represent any relation of the form

$$Y(y)=A(a)\cdot B(b)\cdot C(c)\cdot D(d)\cdot\cdots. \qquad (2)$$

In equation (1) or (2) all variables are distinctly separated. It may occur, however, that one of the functions is itself a function of two or more variables and the relation to be represented can be written as

$$Y(y)=A(a)\cdot B(b)\cdot C(c)\cdot\cdots Z[E(e)\cdot F(f)\cdot G(g)]. \qquad (3)$$

If we denote

$$z=E\cdot F\cdot G \qquad (4)$$

then equation (3) is already in the form of (2) but z has to be worked out separately. This can

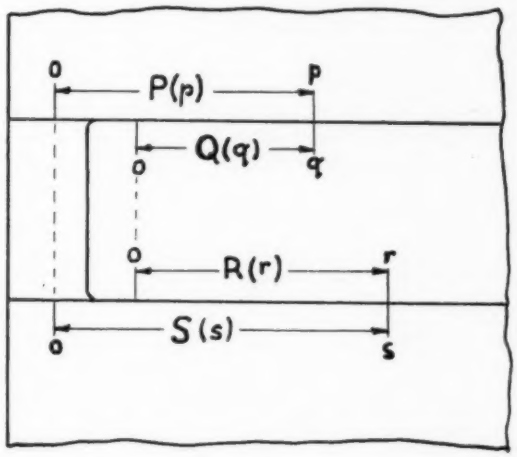

Fig. 2. Basic form of a slide rule showing relation between four variables of the form $S(s)=P(p)-\mathcal{Q}(q)+R(r)$.

be done by using the same slide rule principle again and Figure 3 shows how the two systems can be combined in one instrument. The slide of Figure 2 is extended to a complete slide rule to work out relation (4).* The obtained value of z must be transferred to the main system to conclude the calculation. Generally, one will not be interested in the actual value of z or $Z(z)$ so that the notations can be replaced by a system of lines connecting points of equal z values. Since these lines connect points wherever they may be situated, it follows that the two systems are completely independent of each other and convenient different units of length can be chosen in each. It is thus possible to adjust the relative length and position of the two z-scales so that the resulting transfer line system will not be excessively oblique.

* Several slides would be required if Z should be a function of more than three variables.

The dose from a radium needle at a point opposite its center was given by Sievert[5,6] as

$$D=\frac{2MTN}{la}\cdot F(\mu d,\ l/2a) \qquad (5)$$

where M is the radium content, l the active length, T the time, a the distance from the needle axis and μ the absorption coefficient of the wall material of thickness d. N is a conversion constant to obtain the result in roentgens† and $F(\mu d,\ l/2a)$ represents an intractable integral, tables for which have been published by Sievert[5,6].

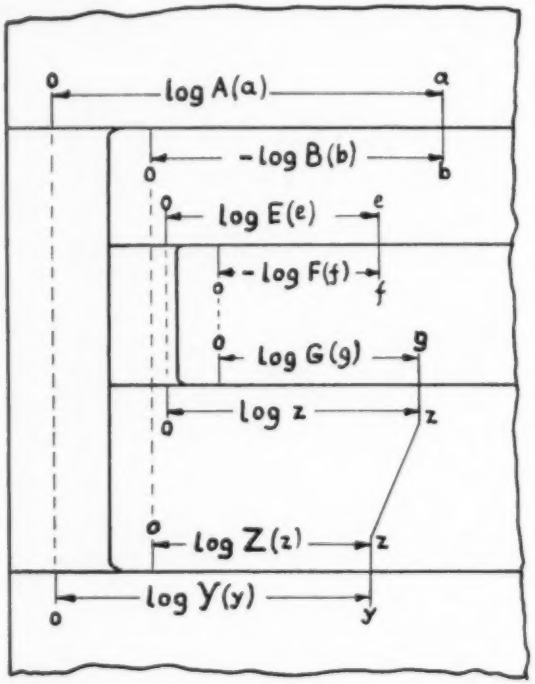

FIG. 3. Extended form of slide rule showing relation between six variables of the form $Y(y)=A(a)\cdot B(b)\cdot Z[E(e)\cdot F(f)\cdot G(g)]$. (The negative signs, e.g. $=\log B(b)$, are necessary because subtraction of a logarithm corresponds to division, subtraction of a negative logarithm, therefore, corresponds to multiplication.)

In the stated form, equation (5) cannot yet be represented by a slide rule as F is a function of two parameters, μd and $l/2a$. This difficulty was overcome by giving μd a constant value corresponding to a medium filtration of 0.8 mm. *Pt* and allowing for other filtrations in form of a correction factor as described in the main text. It will further be seen that both l and a occur not only as parameters of F but also as independent factors. It might appear, therefore, that each system would have to contain scales for l and a which would greatly reduce the value of the slide rule. In this particular case, however, a solution is possible where no scales are repeated. Rearranging (5) and at the same time giving d the value of 0.08 cm. gives

$$D_{0.8Pt}=\frac{M\cdot T}{l^2}\cdot P(l/2a),\quad \text{where}$$

$$P=4\cdot N\cdot l/2a\cdot F(0.08\mu,\ l/2a). \qquad (6)$$

Equation (6) has the form of (3) but l still occurs twice. The two required l-scales have been placed at the position corresponding to the b- and e-scales in Figure 3, and since the units of length in the two systems are independent of each other the two l-scales which are logarithmic scales can be made identical in spite of the different powers of l involved, so that really only one scale appears on the slide rule. By this method the units of length in the two systems have been disposed of and the transfer line system must be accepted in whatever form it appears. It turned out to be very satisfactory. The g-scale of Figure 3 is reduced to a single transfer mark as P depends on two variables only.

Needles are frequently filled with radon which decays relatively quickly. The factor T in (5) or (6) must then be replaced by $(1-e^{-\lambda t})/\lambda$ to allow for the decay where $\lambda=0.181$ days^{-1} is the decay constant of radon.

The scale for "Decay of Radon" (Fig. 1) is of course derived from the formula $\mathcal{Q}=\mathcal{Q}_o\cdot e^{-\lambda t}$ where $\mathcal{Q}$ is the amount of radon remaining after a time T if the initial amount is $\mathcal{Q}_o$. This can be represented by a simple application of the basic slide rule principle in Figure 2. The s-scale is identical with the p-scale and the r-scale is not required because there are only three variables. The s- and p-scales can therefore be combined in a single scale.

In order to obtain a convenient arrangement of the scales it becomes necessary to introduce suitable constant factors in the formula without, however, altering the result, e.g. multiply both sides of (6) by 100. The D-scale is then re-

† N is the specific emission of gamma rays from an unfiltered point source of radium at 1 cm. distance. As pointed out before, a value of 8.0 r/mg-hr. for a filtration of 0.5 mm. Pt has been adopted. N must therefore be taken as

$$8.0.\ e^{+0.08\mu}=8.84 \text{ r/mg-hr. } (\mu_{Pt}=2.0 \text{ cm.}^{-1})$$

placed by a scale for 100 D while on the right hand side the factor 100 can be combined with any of the functions. With logarithmic scales this merely corresponds to a shifting of the scales and a few trials will soon give a good arrangement. The ultimate design is described in the main text.

The author wishes to express his thanks to Dr. Sylvia Bray, Radium Registrar at this Hospital, for the continuous interest shown in this work.

SUMMARY

A multiple slide rule is described which permits quick calculation of the dose delivered by radium or radon needles as used in gamma-ray therapy. It can also be used for rapid determination of relations between quantities effecting the dose. The theory of the design is outlined and some details are given regarding the mechanical construction of a simple model. The accuracy obtainable is sufficient for clinical use.*

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* After posting the manuscript of this paper, a publication by B. S. Wolf on "Radium Dosage for Linear Sources" became available to the author (AM. J. ROENTGENOL. & RAD. THERAPY, 1943, *50*, 400–405) and this paper should also be referred to here. Particularly the method of obtaining filtration correction factors as applied to the slide rule is an extension of the principle described by Dr. Wolf.

A NOMOGRAM FOR THE EVALUATION OF INTERMITTENT RADON TREATMENT

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IN THE use of superficial applicators certain rules regarding the distribution of radium should be adhered to to ensure uniform irradiation of the area treated. Available radium needles with their long inactive ends will often not fit a given area and the treatment time which is equivalent to that for a radium applicator of equal initial strength. For this reason a nomogram was designed to permit the quick solution of the problem. In Figure 1 the left scale represents treatment time per day while the

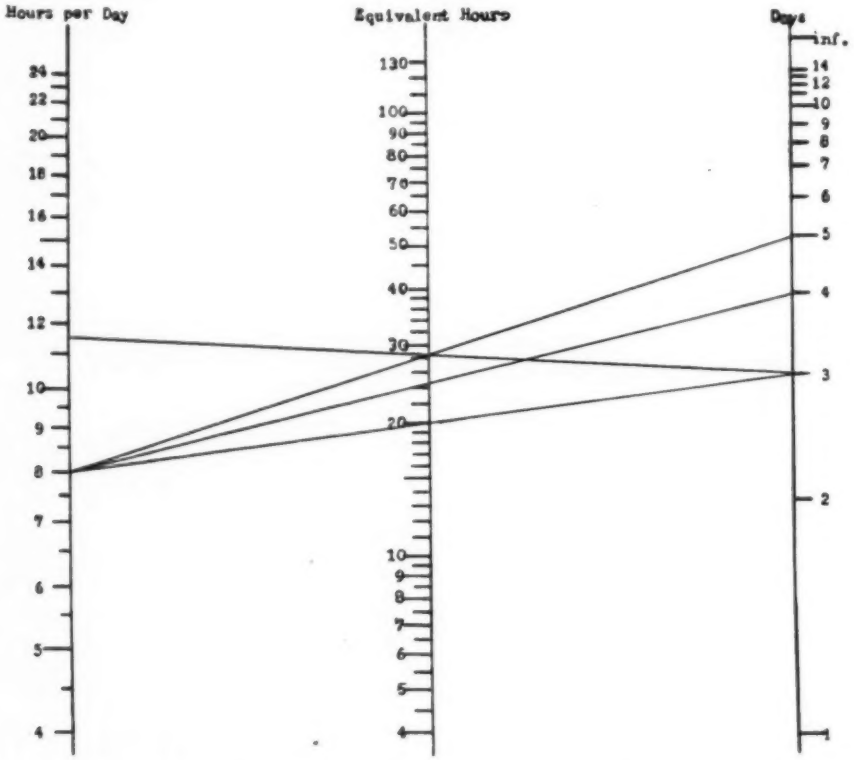

FIG. 1. Nomogram for the evaluation of intermittent radon treatment.

are particularly unsuitable for strongly curved surfaces. Radon needles or small pieces of capillary are much more satisfactory as they can be obtained at any strength required and are active over practically their whole length.

Whenever possible, it is desirable to treat patients as outpatients for a number of hours per day. In the case of radon applicators it is rather cumbersome to evaluate right scale shows the number of days. A straight line connecting the proper scale divisions intersects the middle scale at a point showing the equivalent hours (sometimes also called milligram-hours per initial millicurie). For example, a radon treatment of 8 hours per day over 5 days is equivalent to 28.5 hours using radium of equal initial strength. It is seen that the same equivalent hours could also be ob-

tained by treating 11.5 hours per day over 3 days.

Sometimes the treatment is interrupted for one day (e.g. a Sunday) and the contribution of this day must be subtracted from the equivalent hours. This is easily done as is best seen by an example. Suppose under the conditions given above the fourth day is to be omitted from treatment. The equivalent hours for 4 days are 24.5 hours and for 3 days they are 20 hours. Clearly, the contribution of the fourth day is then $24.5-20=4.5$ hours which must be subtracted from the previous value of 28.5 hours. The resulting treatment is thus equivalent to 24 hours using radium.

It must be realized that intermittent radon treatments require greatly increased amounts of radon compared with those necessary for continuous treatments and the increase may easily become prohibitive, particularly for large applicators. Nevertheless, the described nomogram has been found very useful at this Hospital.

APPENDIX

In the following, the formula is derived on which the nomogram is based. For the actual design of it, however, reference should be made to any textbook on graphical computation.

If $\mathcal{Q}_0$ is the number of millicuries of radon at the beginning of treatment then the amount remaining after a time t is given by $\mathcal{Q}=\mathcal{Q}_0 \cdot e^{-\lambda t}$ (If t is stated in days the decay constant $\lambda=0.181$ days^{-1}.) The dose delivered during a time element dt is proportional to $\mathcal{Q} \cdot dt$ and the total dose is proportional to the sum of all contributions. For the first day this becomes

$$\mathcal{Q}_0 \int_0^{n/24} e^{-\lambda t} dt$$

where n is the number of hours treated per day. A similar integral applies for the second day with its upper and lower limit increased by one (day), viz.:

$$\mathcal{Q}_0 \int_1^{1+n/24} e^{-\lambda t} dt.$$

If treatment is carried out for N consecutive days then a sum of N such integrals is obtained. In case of radium treatment the dose does not depend on the time distribution and simply becomes proportional to $\mathcal{Q}_0 \cdot T$. T is thus defined as the number of equivalent hours and becomes

$$T_{\text{hours}} = 24 \sum_{\nu=0}^{\nu=N-1} \int_{\nu}^{\nu+n/24} e^{-\lambda t} dt$$

$$= 24 \sum_{\nu=0}^{\nu=N-1} \frac{1}{\lambda} \cdot \left[e^{-\lambda \nu} - e^{-\lambda(\nu+n/24)} \right].$$

The factor 24 is necessary because λ is referred to days and T is measured in hours. Taking the constant factors in front of the sum leaves a simple geometric progression the sum of which can be worked out by elementary algebraic rules.

$$T = \frac{24(1-e^{-\lambda n/24})}{\lambda} \cdot \sum_{\nu=0}^{\nu=N-1} e^{-\lambda \nu}$$

$$= \frac{24(1-e^{-\lambda n/24})}{\lambda} \times \frac{1-e^{-\lambda N}}{1-e^{-\lambda}} = f(n) \times F(N).$$

T is thus given as product of two factors of which one depends only on n and the other only on N. Such relations are conveniently represented by an alignment chart consisting of three parallel and equidistant scales as described in the paper.

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EDITORIALS

NONTUBERCULOUS PULMONARY CALCIFICATION

CALCIFIED pulmonary lesions have been the source of much speculation and investigation since Sayers and Meriwether's report[1] on miliary lung disease due to an unknown cause. And now calcified pulmonary lesions assume greater and greater significance in view of the mass surveys of chests that are being made in the general population and in view of the fact that roentgen findings are often the basis for rejecting numbers of persons for the Armed Services. One of the significant problems involves the marked variation in the different parts of the country in the frequency of pulmonary calcification observed in roentgenograms of the chest. The important significance of this was recently brought out in a paper by Long and Stearns[2] based on Selective Service records in which they showed the prevalence of calcified lesions in the lung to vary from 6 per cent in Oregon to 28 per cent in Kentucky. It has been known for some time that an area of high prevalence of calcified pulmonary lesions occurs in the central half of the United States, namely, in Kentucky, Arkansas, Illinois, Indiana, Iowa, Maryland, Mississippi, Missouri, North Carolina, Ohio, Tennessee, Virginia and West Virginia, with a frequency generally lower in the states to the north, south and west of that area.

While pulmonary calcification is generally interpreted as evidence of healed tuberculosis, certain investigators have concluded that tuberculosis is by no means the only disease which brings about such lesions. Lumsden and Dearing observed a marked tendency to geographic distribution of pulmonary calcification and this was associated closely with the occurrence of limestone and chert formations.[3] Since these calcified pulmonary lesions occurred in a large proportion of persons who had negative tuberculin reactions a diligent search has been made for nontuberculous origins of the lesions.[4]

A number of investigators believe that essentially all pulmonary calcification is due to tuberculosis in spite of a negative tuberculin reaction, the assumption being that in such cases sensitivity to tuberculin has been lost with the healing of the tuberculous lesion, whereas there are those who take issue with this explanation because many of the cases occur in children and that repeated tuberculin tests in this group of cases have shown an extremely low rate of positives.

Recently Palmer[5] has had an opportunity to study the question of tuberculin negative pulmonary calcifications. This opportunity was afforded in an extensive investigation on tuberculosis in student nurses which was conducted cooperatively by the National Tuberculosis Association, the United States Public Health Service and a large number of tuberculosis specialists throughout the country.

Approximately 10,000 student nurses in sixty-five nursing schools in nine widely distributed metropolitan centers were under close observation. The study included

[1] Sayers, R. R., and Meriwether, F. V. Miliary lung disease due to unknown cause. Am. J. Roentgenol. & Rad. Therapy, 1932, *27*, 337–351.

[2] Long, E. R., and Stearns, W. H. Physical examination at induction. *Radiology*, 1943, *41*, 144–150.

[3] Editorial. Calcified pulmonary lesions. Am. J. Roentgenol. & Rad. Therapy, 1943, *49*, 823–825.

[4] Lumsden, L. L., and Dearing, W. P. Epidemiological studies of tuberculosis. *Am. J. Pub. Health*, 1940, *30*, 219–228.

[5] Palmer, C. E. Nontuberculous pulmonary calcification and sensitivity to histoplasmin. *Pub. Health Rep.*, May 11, 1945, *60*, 513–520.

a tuberculin test and 14 by 17 inch chest roentgenograms at six month intervals. The results of this study bring out clearly the geographic regional differences in the frequency of pulmonary calcification as well as the fact that, especially in states in the central eastern part of the country, the majority of nurses with calcification have negative tuberculin reactions.

During this study, attempts were made to determine the etiology of the pulmonary calcification in tuberculin negative persons, and a study of the various fungi seemed indicated, especially since some reports have stressed *Coccidioides immitis* as an important pulmonary pathogen. Intradermal tests with coccidioidin were given to a sample group included in the study of student nurses in Detroit, Kansas City, Philadelphia and Baltimore. The results were essentially negative since only a very few reactors to coccidioidin were found, and many of the nurses who reacted to this test had lived or traveled in the southwestern part of the country or in California where coccidioidomycosis is known to be endemic.

Palmer and his associates investigated the possibility that infection with *Histoplasma capsulatum* might be a cause of pulmonary calcification and a large number of nurses were given intradermal histoplasmin tests. The results of this test would indicate that infection with histoplasma is very common in widespread localities in the United States, and that it is probably the principal nontuberculous cause of pulmonary calcification. Palmer's conclusions are based on the assumption that skin sensitivity to the histoplasmin used in his study is indicative of infection with histoplasma.

Meleny, some time ago, expressed his belief that histoplasmosis is not as infrequent as might be supposed, that its infrequency is assumed because it is rarely diagnosed, that the organism is widely distributed throughout the world, and that it would undoubtedly be recognized with increasing frequency in the future as a cause of hitherto unexplained illnesses.[6]

In order to insure uniformity in the interpretation of findings in the study conducted by Palmer, all skin tests were performed and read by one person and all roentgenograms of the chest were interpreted by one experienced roentgenologist. The roentgen findings in this particular study on nontuberculous pulmonary calcification were limited to a report as to the presence or absence of shadows characteristic of calcification in the lung parenchyma or lymph nodes. The roentgen findings were interpreted and recorded without knowledge of the tuberculin reaction and prior to the testing with histoplasmin.

Palmer thinks it is clear from the data collected that there are wide geographic differences in the frequency of the reactions to histoplasmin. Among the group of nurses who had lived essentially all their lives in Minnesota less than 5 per cent showed any reaction to histoplasmin, while in Missouri more than 60 per cent were sensitive. He believes that this geographic distribution may be interpreted as evidence that the histoplasmin reaction is specific indication of some previous experience of the individual, presumably infectious, since it would be difficult to account for such a variation if the reaction were nonspecific. In addition, the consistent high degree of correlation of the histoplasmin reaction with pulmonary calcification in the various localities is similar indirect evidence of its specificity and of its medical significance.

It is known that infection with histoplasma may produce a fatal disease in recognized cases. Since numerous immunological cross reactions are known to exist among bacteria, it seems best in the present state of our knowledge to interpret the histoplasmin reaction as evidence of previous infection with *Histoplasma capsulatum* or an immunologically related organism.

Palmer states that if the interpretation of the specificity of the histoplasmin test is correct, a number of important implica-

[6] Editorial. Histoplasmosis. Am. J. Roentgenol. & Rad. Therapy, 1942, *47*, 792–793.

tions at once become apparent. First, histoplasmosis, in the mild, perhaps subclinical form, may be a common infection, at least in the states in the central eastern half of the country. The number of persons so affected in this area may total many millions. The epidemiological evidence indicates that a high proportion of the pulmonary calcification observed in individuals living in this group of states may be due to an infection with histoplasma or a related organism and not to tuberculosis. If this assumption proves to be correct, a number of problems in the study of tuberculosis may be clarified.

Thus, Palmer, in his study of a large group of nurses in widely separated states, has pointed out a possible further cause of pulmonary calcification which has until recently been attributed to tuberculosis. Further studies are awaited to confirm or disprove Palmer's interesting observation.

VERNOR M. MOORE
1886–1944

DR. VERNOR M. MOORE, a member of the American Roentgen Ray Society since 1925, died at his home in Grand Rapids, Michigan, December 30, 1944, after a sudden and short illness.

Born at Freeport, Michigan, February 10, 1886, he obtained his pre-medical training at Olivet College and graduated from the Medical School of the University of Michigan with the class of 1911. Following two years of general practice he became associated with the late Dr. Richard R. Smith. In 1916 Dr. Moore opened his office for the private practice of radiology in the

Metz Building where he continued his practice until his death.

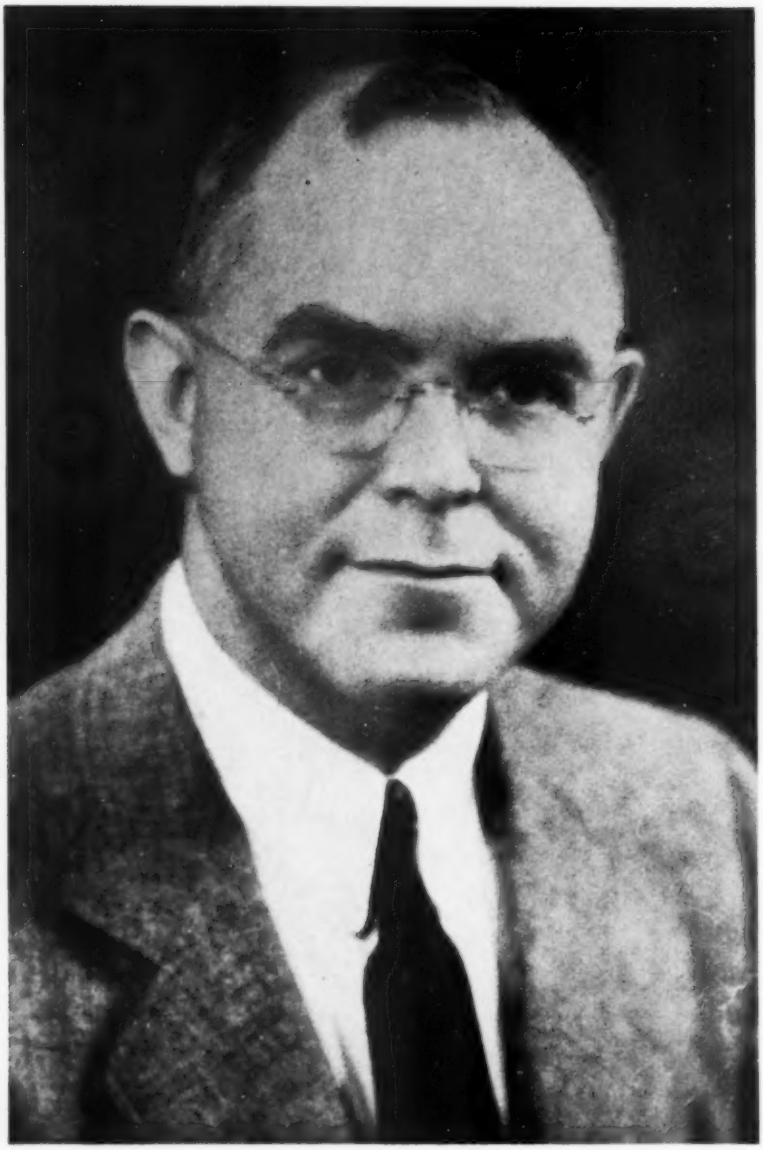
Dr. Moore was greatly interested and took a very active and prominent part in the work of organized medicine. He acted as Councilor for ten years, one year as chairman of the Executive Committee of the Council and at the time of his death was President-elect of the Michigan State Medical Society.

Early in his medical career, Dr. Moore became very much interested in chest pathology. He was a member of the Board of Directors of the Kent County Anti-tuberculosis Society. He was held in high regard for his ability as a radiation therapist.

Dr. Moore was a Past President of the Kent County Medical Society and the Michigan Association of Roentgenologists. He held membership in the Radiological Society of North America and was a diplomate of the American Board of Radiology.

A sincere and loyal friend, never too busy to assist those starting in the practice of medicine, Dr. Moore will be greatly missed by his many friends and colleagues.

Leland E. Holly



RALPH EMERSON MYERS
1888–1945

DR. RALPH EMERSON MYERS was born on January 28, 1888, at Buskirk, New York, the son of Dr. Adam Y. and Mary E. Myers. He obtained his early training at private school and the Hoosick Falls High School, from which he was graduated in 1904. After an additional year's work, he entered Wesleyan University, Middletown, Connecticut, in the fall of 1905 and became engrossed in the study of Greek and Latin. In 1907 he transferred to Yale University and received his B.A. from there in 1909 with honors and election to Phi Beta Kappa and Sigma Xi. At Yale

he turned his attention from the classics to science and mathematics, becoming interested in physiological chemistry under the stimulating teaching of the late Professor Lafayette B. Mendel. He spent an additional year's work in this field and received an M.A. from Yale in 1910. Deciding to try his hand at the practical side of biochemistry he became chief chemist at the Battle Creek Sanitarium. After less than a year he resigned this position to accept an Austin Teaching Fellowship in Physiology at the Harvard Medical School under Professor Walter B. Cannon. He remained there until the fall of 1912, when he accepted an appointment at the Albany Medical College (Union University) as lecturer in pharmacology and physiology. The following year he was promoted to an adjunct professorship in these subjects.

At this point in his career he was intensely interested in pharmacology and, believing that the German text, Gottlieb and Meyer, gave the best presentation of the subject, he prepared a translation for his own students. He was planning to go to Vienna to work in pharmacology with Professor Hans Horst Meyer when the first world war caused a change in his plans. He then decided without further delay to complete work for a medical degree and entered Cornell University Medical College, New York, in the fall of 1914. A considerable number of medical subjects had already been taken at Yale and Harvard, so that scarcely three years were required to complete the required course. The fourth year was occupied with an internship at the Memorial Hospital. While an intern he spent considerable time in administering radium for Dr. H. H. Janeway at Memorial Hospital and this doubtless materially influenced his subsequent career in radiology. Upon receiving his M.D. in 1918 he was commissioned a First Lieutenant in the Medical Corps of the United States Army and served until the fall of 1919. On his discharge from the Army he was appointed professor of pharmacology at the University of Maryland School of Medicine. He resigned at the end of the year (1920) to accept the professorship of pharmacology and physiological chemistry at the George Washington University School of Medicine. In the spring of 1922 he was offered and accepted the directorship of laboratories at St. Anthony's Hospital, Oklahoma City. Realizing his lack of special training in pathology, he spent the summer at Memorial Hospital in New York with Dr. James Ewing. Dr. Ewing's intense interest in cancer and its treatment must have unconsciously further stimulated his interest in radium and roentgen therapy of malignant tumors. Upon his arrival at St. Anthony's Hospital in Oklahoma City to assume the directorship of laboratories he found that the Department of Radiology was nominally under his charge, necessitating his giving more attention in this direction than he had anticipated, with the result that he soon found himself intensely interested in radiology. In 1929 after having held the post of director of laboratories for seven years he resigned in order that he might devote his entire time to radiology, in which field he gained wide recognition.

In addition to membership in the American Radium Society, he was a fellow of the American College of Radiology, held a certificate from the American Board of Radiology, and was a member of the Radiological Society of North America, the American Medical Association and the American Association for the Advancement of Science. He served as Secretary and later as Chairman of the Section on Radiology of the Southern Medical Association. He died on March 14, 1945 from meningitis due to type III pneumococcus after an illness of two days. A wife, Lucy, whom he married in 1919, and a brother, Victor, survive.

Victor C. Myers

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: 1945, canceled.

AMERICAN COLLEGE OF RADIOLOGY
Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio. Annual meeting: 1945, canceled.

ARKANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Ark. Meets every three months and also at time and place of State Medical Association.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: 1945, to be announced.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY
Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION
Secretary, Dr. Earl R. Miller, University of California Hospital, San Francisco, Calif.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY
Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL ASSOCIATION
Secretary, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. Roy G. Giles, Temple, Texas.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. Leo Harrington, 880 Ocean Ave., Brooklyn, N.Y. Meets monthly on fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. F. H. Squire, 1754 W. Congress St., Chicago 12, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY
Secretary, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. D. D. Brannan, 11311 Shaker Blvd., Cleveland 4, Ohio. Meets at 6:30 P.M. at Allerton Hotel on fourth Monday each month, October to April, inclusive.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meetings held in Dallas on odd months and in Fort Worth on even months, on third Monday, at 7:30 P.M.

DENVER RADIOLOGICAL CLUB
Secretary, Dr. A. Page Jackson, Jr., 1612 Tremont Place, Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY
Acting Secretary, Dr. Walter A. Weed, 204 Exchange Bldg., Orlando, Fla. Meetings in May and November.

GEORGIA RADIOLOGICAL SOCIETY
Secretary, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

RADIOLOGICAL SOCIETY OF KANSAS CITY
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meets annually second Sunday in May.

IOWA X-RAY CLUB
Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KENTUCKY RADIOLOGICAL SOCIETY
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

LONG ISLAND RADIOLOGICAL SOCIETY
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

LOUISIANA RADIOLOGICAL SOCIETY
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS
Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY
Secretary, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.

NEBRASKA RADIOLOGICAL SOCIETY
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

NEW HAMPSHIRE ROENTGEN RAY SOCIETY
Secretary, Dr. Richard C. Batt, Berlin, N. H. Four meetings a year.

RADIOLOGICAL SOCIETY OF NEW JERSEY
Secretary, Dr. H. R. Brindle, 501 Grand Ave., Asbury Pk. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA ROENTGEN RAY SOCIETY
Secretary, Dr. Major Fleming, Rocky Mount, N. C. An-

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

nual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

North Dakota Radiological Society
Secretary, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.

Central New York Roentgen Ray Society
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

Ohio Radiological Society
Secretary, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio. Meets during annual meeting of Ohio State Medical Association.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. L. E. Wurster, 416 Pine St., Williamsport.

Philadelphia Roentgen Ray Society
Secretary, Dr. C. L. Stewart, Jefferson Hospital, Meetings first Thursday of each month, October to May, at at 8:00 P.M., in Thomson Hall, College of Physicians, 21 S. 22d St.

Pittsburgh Roentgen Society
Secretary, Dr. L. M. J. Freedman, 4800 Friendship Ave. Meets 6:30 P.M. at The Ruskin on second Wednesday, each month, October to May inclusive.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary Dr. A.M. Popma, 220 N. First St., Boise, Idaho.

St. Louis Society of Radiologists
Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September, at a place designated by the president.

San Diego Roentgen Society
Secretary, Dr. Henry L. Jaffe, Naval Hospital, Balboa Park, San Diego, Calif. Meets monthly on first Wednesday at dinner.

San Francisco Radiological Society
Secretary, Dr. Carlton L. Ould, University of California Hospital, San Francisco 22. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.

Shreveport Radiological Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

South Carolina X-Ray Society
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. Asa E. Seeds, Baylor Hospital, Dallas, Texas. Next annual meeting, Temple, Texas, Jan. 17, 1945.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00–5:00 P.M., Room 301, Service Memorial Institute.

Virginia Radiological Society
Secretary, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

X-ray Study Club of San Francisco
Secretary, Dr. J. M. Robinson, University of California Hospital. Meets monthly, third Thursday evening.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month at 4:45 P.M. at the Royal Society of Medicine 1, Wimpole St., London, W. 1.

Faculty of Radiologists
Secretary, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1 England.

Section of Radiology and Medical Electricity, Australasian Medical Congress
Secretary, Dr H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

Canadian Association of Radiologists
Secretary, Dr. J. W. McKay, 1620 Cedar Ave., Montreal, P. Q.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

South America

Sociedad Argentina de Radiologia
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

Sociedad Peruana de Radiologia
Secretary, Dr. Victor Giannoni, Apartado, 2306, Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión, Villalta, 218, Lima.

Continental Europe

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. A. Grosjean La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse Biel. Meets annually in different cities.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY

The Thirtieth Annual Meeting of the Pennsylvania Radiological Society was held at the William Penn Hotel, Pittsburgh, Pennsylvania, on May 5 and 6, 1945. On Saturday, May 5, the following scientific program was presented:

Management of Fractures. John R. Moore and W. E. Chamberlain, Philadelphia, Pa.
Odds and Ends. John M. Keichline, Huntingdon, Pa.
Roentgenographic Diagnostic Experiences in a Small General Hospital. John H. Harris, Harrisburg, Pa.
Wilms' Tumor. William J. Corcoran, Scranton, Pa.
An Unusual Abdominal Tumor. F. N. Hoffmeier, Hagerstown, Md.
Injuries about the Elbow Joint. George W. Chamberlain, Reading, Pa.
Experiences in the Treatment of Tinea Capitis. Lester M. J. Freedman, Pittsburgh, Pa.
Heart Size in Infants and Children. Sidney J. Hawley, Danville, Pa.
Intestinal Polyposis. Leslie H. Osmond, Pittsburgh, Pa.

The meeting on Sunday, May 6, was given over to a discussion of "Interesting Diagnostic and Treatment Cases," with Sidney J. Hawley, Danville, Pa., as Chairman.

PHILADELPHIA ROENTGEN RAY SOCIETY

At the recent meeting of the Philadelphia Roentgen Ray Society the following officers were elected: *President*, Dr. Paul C. Swenson; *Vice-President*, Dr. Louis Edeiken; *Secretary*, Dr. Calvin L. Stewart; *Treasurer*, Dr. David A. Sampson.

PITTSBURGH ROENTGEN SOCIETY

At the recent meeting of the Pittsburgh Roentgen Society the following officers were elected for the ensuing year: *President*, Dr. Reuben G. Alley, Pittsburgh; *Vice-President*, Dr. Paul Meader, Pittsburgh; *Secretary-Treasurer*, Dr. Lester M. J. Freedman, Pittsburgh.

NEW ENGLAND ROENTGEN RAY SOCIETY

At its meeting on May 18, 1945, the New England Roentgen Ray Society paid honor to its distinguished member, Dr. George W. Holmes, pioneer radiologist and teacher, by establishing an annual lecture to be known as the George W. Holmes Annual Lecture.

The following officers were elected: *President*, Dr. Philip Batchelder; *Vice-President*, Dr. Robert G. Vance; *Secretary*, Dr. George Levene.

RADIOLOGICAL SOCIETY OF NEW JERSEY

At the annual meeting of the Radiological Society of New Jersey held on May 16 1945, the following officers were elected: *President*, Dr. H. J. Perlberg, Jersey City, N. J.; *Vice-President*, Dr. John Olpp, Englewood, N. J.; *Secretary*, Dr. H. R. Brindle, Asbury Park, N. J.; *Treasurer*, Dr. W. H. Seward, Orange, N. J.

CANCER TEACHING DAY

A Cancer Teaching Day was held at Binghamton, New York, on Wednesday, June 6, 1945, under the auspices of various medical societies. The following papers were presented at the afternoon session: "Treatment of Cancer of the Cervix" by Howard C. Taylor, Jr., M.D.; "Cancer of the Stomach" by George T. Pack, M.D. Following a dinner, these papers were presented at the evening meeting: "Malignancies of the Genitourinary Tract" by Ernest M. Watson, M.D.; "Cancer of the Breast" by Norman Treves, M.D.

COLONEL ALFRED A. DE LORIMIER RECEIVES ARMY AWARD

The following citation appearing among the Army Awards and Commendations in the *Journal of the American Medical Association* for May 5, 1945, Vol. 128, page 35, will be of interest to all readers of the JOURNAL. Colonel de Lorimier is a well

known radiologist and is a member of the American Roentgen Ray Society:

Col. Alfred A. de Lorimier, formerly of Washington, D. C., was recently awarded the Legion of Merit for "service as director of the Department of Roentgenology, Army Medical School, Army Medical Center, Washington, D. C., from Sept. 8, 1939 to Oct. 1, 1942. He developed an easily transportable, complete and efficient field x-ray equipment for the Army which permits the location of bullets and shell fragments in the body of a wounded man and makes it possible for the surgeon to extract them. He tested all types of roentgenologic materials procured for the Army and formulated the specifications necessary for their purchase. He made extensive studies of the use of photoroentgenography and was instrumental in developing stereoroentgenography, which has a valuable use in induction centers and in mass surveys. By his initiative, original thinking and development work he has performed outstanding service and contributed materially to the war effort." Dr. de Lorimier graduated from the University of California Medical School, San Francisco, in 1927 and entered the service May 10, 1929.

AMERICAN BOARD OF RADIOLOGY

The examination of the American Board of Radiology originally scheduled for New York in June was canceled. The next examination will be held in Chicago some time in the fall of this year. Due notice will be sent out as soon as the time and place have been decided upon.

B. R. Kirklin, *Secretary*

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

GYNECOLOGY AND OBSTETRICS

McSweeney, Daniel J., and Moloney, Albert M. Combined x-ray and external pelvimetry. *Am. J. Obst. & Gynec.*, July, 1943, *46*, 102–109.

The authors set down the following criteria as determining the need for roentgen examination:

1. Primiparas with floating heads at term.
2. Multiparas with a history of previous difficult deliveries.
3. Primiparous breeches with apparently small pelves by external measurements (an external conjugate of less than 18.5 cm.).
4. Cases with narrow subpubic arches and outlets (a subpubic measurement of less than 6 cm.; intertuberous measurement less than 9.0 cm.; sum of intertuberous and posterior sagittal measurements of less than 15.0 cm.).
5. Elderly primiparas with an external conjugate of 18.5 cm. or less.

The roentgen examination consists of:

1. A roentgenogram directly through the pelvic inlet.
2. A true lateral view on which is measured the conjugate vera, the anterior sagittal, posterior sagittal, the anteroposterior diameter of the mid-pelvis, the pubotuberous diameter and the biparietal diameter of the fetal head.

Assuming the fetal head to be average size, the question of probable dystocia at the various planes can be reduced to the following simple observations.

1. Dystocia at the Inlet—Measurements
   - Conjugate vera under 10 cm. in generally contracted pelvis
   - Conjugate vera under 9.5 cm. in flat pelvis
   - Contour
   - Angulation of forepelvis
   - Flattened posterior pelvis
2. Dystocia at Mid-pelvis—Measurements
   - Posterior sagittal under 3.5 cm.
   - Subpubic arch under 5.5 cm.
   - Contour
   - Converging sacrum and pubis
   - Sacrococcygeal platform
3. Dystocia at Outlet—Measurements
   - Interpubic under 5.5 cm.
   - Intertuberous under 9.0 cm.
   - Pubotuberous over 11.0 cm.
   - Contour
   - Acute rather than obtuse arch.—*Mary Frances Vastine.*

Thoms, Herbert. The relation of the sacral promontory to the pelvic inlet. *Am. J. Obst. & Gynec.*, July, 1943, *46*, 110–116.

In this investigation the roentgenologic findings in 200 primigravid women have been studied. Because of the wide variation in position of the sacral promontory in its relation to the bony pelvic canal, some modern investigators have found that for clinical purposes it is necessary to abandon the idea that the superior strait, as described in anatomic texts, should be considered as the plane of the obstetric pelvic inlet. Thus, the position of the forward edge of the sacral promontory is too unreliable to be considered as the posterior end of the true conjugate diameter. From an obstetric point of view the plane of the pelvic inlet is considered to be bounded anteriorly by the upper posterior surface of the pubic symphysis and forward position of the iliopectineal lines, laterally by the iliopectineal lines and posteriorly by the posterior portions of these lines and the anterior upper surface of the sacrum at the point where convergence of these lines takes place. It seems that the diagonal conjugate cannot be considered as a reliable index to the true conjugate and that in some cases information so obtained may be misleading.

In the series studied, an attempt was made to find out if high positions of the promontory were associated with any particular pelvic grouping according to the division into dolichopellic, mesatipellic, brachypellic, and platypellic types. From the analysis it was apparent that no definite conclusions may be drawn and that the high promontory position is somewhat, if but slightly, associated with the dolichopellic and mesatipellic types of pelvis.

Also in the present series, the reliability of the diagonal conjugate diameter as an index of the true conjugate diameter was determined. For this purpose 1.5 cm. was deducted from the diagonal conjugate and a leeway of 0.25 cm. plus or minus was allowed for the true conjugate. The result showed that the diagonal conjugate could be used as a satisfactory criterion in 76 instances, or *but 38 per cent of the cases.—Mary Frances Vastine.*

Kantor, Herman I. Parasitic ovarian cysts. *Am. J. Obst. & Gynec.*, Sept., 1943, *46*, 412–417.

Morgagni is reputed to have described parasitic ovarian tumors as early as 1748. However, today, they are rather unusual, undoubtedly because operation is performed earlier for symptoms suggesting torsion of an ovarian tumor. Among the ovarian parasitic tumors, the type most frequently seen is the dermoid.

The development of parasitic tumors may be divided arbitrarily into four stages:

First Stage. Reduction in blood supply due to slow torsion of the mass on its pedicle.

Second Stage. Adhesions formed between the mass and adjacent tissues of the omentum.

Third Stage. Additional torsion and further decrease in the primary blood supply.

Fourth Stage. Additional torsion to the point of complete amputation of the pedicle.

A case is reported in which the patient's complaint was "attacks of pain localized to the right quadrant." The roentgenologist reported, " . . . several clusters of calcification within the pelvis, one having the typical appearance of a calcified fibroid. Below this fibroid is another circular calcification which may be an additional fibroid." At operation the right ovary was found to be converted into a multilocular dermoid cyst attached by two pedicles, one communicating with the infundibulopelvic ligament and the other with the peritoneum. Both of these pedicles were twisted. Another cyst was found posterior to the uterus. This was attached completely to the omentum by a pedicle.—*Mary Frances Vastine.*

Hunter, Robert M. An attempt to correlate the pre-eclamptic state with a congenital anomaly of the kidney. *Am. J. Obst. & Gynec.*, July, 1943, *46*, 91–96.

This study from the department of obstetrics at Hahnemann Medical College and Hospital is based on 74 cases divided into three groups:

1. Twenty-two patients with pre-eclampsia.
2. Twenty-five cases of uropathies complicating pregnancy.
3. Twenty-seven normal pregnant women near term.

Routine intravenous urograms were made in all 74 cases. The roentgenograms were read by a member of the roentgen department who was intentionally deprived of any knowledge of the clinical status of the patients. He was asked to state whether the kidney pelves were intrarenal or extrarenal. After all roentgenograms were read, the clinical status was correlated with the roentgenologic status. The following results were obtained: (1) of the 22 toxic cases, 20 patients had intrarenal pelves and 2, extrarenal pelves. (2) Of the 25 patients with uropathic conditions complicating pregnancy who did not have toxemia at the time the urograms were taken, 17 had extrarenal pelves, and 8, intrarenal pelves. (3) In the normal control group, totaling 27 cases, there were 18 with extrarenal pelves and 9 with intrarenal pelves.

The author concludes that an intrarenal pelvis is more common in the pre-eclamptic state than in normal pregnancy, or even in patients with uropathic conditions complicating pregnancy. He suggests that since normally the kidney pelvis is dilated in pregnancy, in the presence of an intrarenal kidney pelvis the resulting increased intrarenal pressure must of necessity cause back pressure in the kidney tubule. This, in turn, must be compensated for by an increase in glomerular pressure or, in other words, an increase in blood pressure.—*Mary Frances Vastine.*

Thomas, Sydney. Diffuse calcification of the placenta demonstrable in vivo. *Radiology*, Dec., 1943, *41*, 573–575.

Calcification occurs normally in the placenta and should not lead to a diagnosis of disease. The amount of calcium depends on the length of the pregnancy and the mother's calcium metabolism. Such calcifications are generally not demonstrable during life because they are small and spread over a wide area and the fetus is often moving or the uterus contracting and motion is transmitted to the calcified areas by these movements or those of the uterine or aortic vessels. They will probably be seen more frequently since the introduction of the rotating

anode tube and with the use of improved technique.

A case is described in a white primipara nineteen years of age who came for examination at the end of the tenth month of pregnancy on account of hemorrhage. The possibility of placenta previa was considered and roentgenograms made for the purpose of localizing the placenta. The lateral view of the abdomen showed many opacities in the shadow of the placenta. The patient was delivered of a normal female infant ten and a half months after the estimated beginning of the pregnancy. The reticular pattern of the calcifications should always be looked for in suspected placenta previa. —*Audrey G. Morgan.*

SKELETAL SYSTEM

Mock, Harry E. Symposium on injuries of the head, chest, and back; head injuries. *Radiology*, Dec., 1943, *41*, 527–531.

The author is a general surgeon who has made a hobby of collecting cases of fracture of the skull. He has records of a little more than 7,000 cases, 500 of which he has treated himself. He has made two surveys of a large number of hospitals and finds that in the second survey the mortality rate has declined 7 per cent. His own mortality rate ten to twelve years ago was 20–21 per cent, but he has now reduced it to 16 per cent.

He outlines the proper course of treatment and points out factors that cause death. Much depends on careful and close observation of the patient, with blood pressure, pulse, respiration and temperature recorded every two hours and sometimes as often as every half hour. Every case of head injury should have a roentgen examination but not while the patient is in shock, coma or wild delirium. The taking of roentgenograms in the first few hours increases mortality.

He classifies the hospitals examined as having good, average and poor management. In the first group the average mortality was 19 per cent, in the second 25 per cent and in the third 38 per cent. The lowest mortality in any one hospital was 17 per cent and the highest 42 per cent. The cases were of the same type and same average degree of severity. The differences were due to differences in attention to detail.

He cites as pathological causes of death which occur in 10–12 per cent of cases and cannot be prevented: cerebral shock, massive brain lesions, hemorrhages in vital centers, serious associated injuries and complicating diseases. Other causes due to mismanagement and therefore preventable occur in 5 to 15 per cent of cases. They are: failure to treat shock first, failure to observe and chart the course of the injury, a hit or miss type of dehydration, overdehydration and starvation, too few or too late spinal punctures, too few, too many or too early operations and oversedation.—*Audrey G. Morgan.*

Kenning, J. C., and Harris, Ivor D. Some considerations concerning the diagnosis of skull fractures. *Radiology*, Dec., 1943, *41*, 532–538.

Over 50,000 cases of injury of the skull have been given roentgen examination at the Detroit Receiving Hospital in the past eighteen years and about 9,000 of these have shown fractures. In all such cases right and left lateral, frontal and occipital views are taken. Care in technique and the use of the smallest possible focal spot and of the Potter-Bucky diaphragm are important. If there is a questionable line or if a fracture indicated clinically is not found, further roentgenograms are taken showing the suspected area in the greatest detail and with the least possible superimposition.

It has been found that 26.8 per cent of all fractures occur in the anterior third of the skull, 45.3 per cent in the middle third and 27.9 per cent in the posterior third. Linear fractures must be differentiated from suture lines, diploic markings, vascular grooves and artifacts. Roentgenograms illustrating these differentiations and the different types of skull fracture are given.

In fractures of the anterior third the cribriform plate of the ethmoid may be involved, resulting in leakage of cerebrospinal fluid and danger of meningitis and abscess. Involvement of the anterior wall of the frontal sinus is less dangerous than that of the posterior wall. It may be necessary to take roentgenograms at a tangent in order to differentiate between fractures of the anterior and posterior walls. If there is impairment of vision, special orbital views should be taken.

Fractures in the middle area or mastoid region are more dangerous than in the other regions and at the same time more easily overlooked. The mortality increases with increasing involvement of the mastoid. There are few complicating features in fractures of the posterior third or occipital region.

Fractures of the mastoid generally show bony non-union. The time required for union has become more important medicolegally since automobiles have come into use and will be even more so after this motorized war. It has been claimed that a fresh linear fracture can be differentiated from an old one after eight months but this is not always true of fractures of the mastoid and of the base of the skull.—*Audrey G. Morgan.*

MERRIFIELD, FREDERICK W. The management of jaw fractures. *Radiology*, Dec., 1943, *41*, 539–542.

The mandible is the most frequently fractured of the facial bones. The fractures may be partial or complete and they occur most frequently at the angle or at the mental foramen. Fractures are apt to occur at sites of anatomic weakness, for instance in children with unerupted teeth in the cuspid region.

Diagnosis can generally be made from the history of injury and the characteristic appearance. The extent of the injury can be determined by roentgen examination. The entire mandible from one side to the other should be examined.

Treatment consists of care of the soft parts to prevent or minimize infection and reduction of the fragments, which generally brings about restoration of occlusion of the teeth. The teeth act as landmarks for successful reduction and the fragments may be fixed by wiring the teeth. It may be possible to retain teeth even if there is some infection. The mandible heals even when there is severe osteomyelitis if adequate drainage is maintained. Splints are useful in some cases, particularly if there is loss of bone.

The reduction and fixation of fractures of the maxilla and facial bones are also discussed. Diet is an important consideration in the treatment of fractures of the jaws. It should be nourishing and of sufficient vitamin content, and capable of passing through a feeding tube by easy suction. Sometimes nasal feeding must be used. The caloric requirement is from 2000 to 3000.—*Audrey G. Morgan.*

BENNETT, J. PAUL. The roentgenologic diagnosis of chest injuries. *Radiology*, Dec., 1943, *41*, 543–550.

In an introduction to this paper Dr. Mock points out that the association of chest injuries with injuries of the skull enormously increases the mortality of the latter. Chest injuries, always serious, are particularly so when associated with injuries of the brain.

The author discusses the different types of injuries of the chest. In studying the ribs a number of views must be taken, as a fracture may not show if the beam is tangential to the curve of the affected rib. A fracture of cartilage may not show on the roentgenogram unless the cartilage is ossified. Lateral or oblique views are necessary to demonstrate fractures of the sternum. In studying the routine chest roentgenogram the bones should always be observed. Fractures of the ribs or even a fractured dorsal vertebra may be seen. Varying degrees of emphysema may be seen on the roentgenogram, which may be the only evidence of a perforated lung. Pneumothorax may be present, with or without fracture of the ribs. It may be so slight that roentgenograms in both inspiration and expiration are necessary to detect it.

Hemorrhage into the pleural cavity may result from trauma. Blood cannot be distinguished from any other fluid on the roentgenogram. Sometimes on the posteroanterior view encapsulated fluid may simulate pneumonic consolidation, while on the lateral view it shows clearly. Hemorrhage into the lung parenchyma may simulate pneumonia, tuberculosis or other infections. The mediastinal structures may be injured in trauma. Severe damage to the great vessels usually causes almost immediate death but if the patient survives, the mediastinal shadow is broadened and shows straight vertical borders. A blow over the precordium may cause hemorrhage into the pericardium and the roentgenogram shows pericardial fluid. Air is occasionally seen in the pericardium as a clear area between the pericardium and the outline of the heart. Foreign bodies are occasionally seen in the heart muscle or in the chambers. A case is described in which a large piece of glass was not seen on the roentgenogram taken during life but was seen on that of the extirpated heart.

Penetration of the diaphragm may cause subdiaphragmatic hemorrhage and subsequent abscess. Trauma of the diaphragm may result in herniation. The hernia may be confused with eventration of the diaphragm. A left-sided eventration displaces the heart to the right, while a posterior hernia will not. But an anterior hernia may cause such a displacement.

Pneumoperitoneum may be of value in differentiation.

Cases of the different forms of chest injury are described and illustrated with roentgenograms.—*Audrey G. Morgan.*

Mock, Harry E. Back injuries: introduction. *Radiology*, Dec., 1943, *41*, 551–553.

The author calls attention to the great prevalence of low back pain and the many changes there have been in its diagnosis and treatment. These patients generally come to the surgeon and want a definite diagnosis. It is true that there are cases that are definitely surgical and require the removal of a cord tumor, an osteoma or a protruding disc. But often even after a protruding disc has been removed the back pain persists, and often even the removal of foci of infection has not cured the pain. There are other factors—psychogenic, constitutional and postural—which must be taken into consideration. Roentgen examination should be made but the whole responsibility should not be thrown on the roentgenologist. The surgeon should make a thorough physical examination of the patient and not accept slight spinal changes found by the roentgenologist as being necessarily the cause of the pain. Correction of faulty posture and living conditions and the resoration of muscle balance may do much more for the patient than surgery.—*Audrey G. Morgan.*

Carey, Eben J. Anatomical and physiological considerations prerequisites to diagnosis of back trauma. *Radiology*, Dec., 1943, *41*, 554–559.

This thorough review of the anatomy and physiology of the spinal column is given because of the importance of such knowledge in the diagnosis and treatment of low back pain. There are a number of anomalies of the spine that are found in patients who are free of symptoms but their spines are less stable than normal and more prone to strain and injury. They are: (1) elongation of the transverse process of the fifth lumbar vertebra which is found in 25 per cent of the cases of low back pain. This process impinges on the ilium and friction causes a painful bursa; (2) sacralization of the fifth lumbar vertebra. This is found in about 3.5 per cent of normal persons and about half of these have low back pain; (3) defect of the neural arch (spina bifida occulta). This is found in about 5 per cent of spines examined roentgenologically. It renders the spine weak and liable to injury; (4) variations in the spinous processes; (5) variations in the lumbosacral angle; (6) variations in the joint surfaces; (7) spondylolisthesis; (8) constitutional variations. Long thin individuals are apt to suffer sacroiliac sprain while short heavy ones are apt to have lumbosacral sprain.—*Audrey G. Morgan.*

Morton, S. A. The differential diagnosis of traumatic lesions of the spine. *Radiology*, Dec., 1943, *41*, 560–564.

It is often hard to differentiate traumatic from non-traumatic lesions of the spine on the roentgenogram. Fractures and dislocations are of course easily diagnosed but there are other changes apparently due to trauma which are non-traumatic in origin. One of these is non-traumatic dislocation of the atlanto-axial joint, usually seen in young people in association with infections of the throat or of the cervical lymph nodes. Laminagrams are often of value in the diagnosis of this condition. A basal view of the skull is recommended in order to show the relation between the atlas and the axis.

Persons who have had injuries of the neck may complain of pain in the neck and down one or both arms. Roentgenograms in these cases may show spurs projecting posteriorly from the bodies of the cervical vertebrae.

In the dorsal region there are two more non-traumatic conditions that may be mistaken for traumatic ones—collapse of the body of a vertebra from osteoporosis and those changes in the epiphyses of the body of a vertebra commonly called persistent epiphysis. They are really corners of the body of the vertebra pulled off by the action of muscles or ligaments.

Near the lumbosacral junction a congenital defect of the isthmus may be mistaken for a traumatic lesion.

Hypertrophic lesions are questionable. They may be seen in the spines of sedentary persons who have not suffered trauma and they may be absent in the cases of trauma. There is little or no connection between the degree of an injury and the subsequent development of hypertrophic spurs. So there are many cases in which the roentgenologist must be extremely cautious in expressing a dogmatic opinion as to whether a lesion of the spine is traumatic or non-traumatic.—*Audrey G. Morgan.*

LAPIDUS, PAUL W., GUIDOTTI, FRANK P., and COLETTI, C. J. Triphalangeal thumb; report of six cases. *Surg., Gynec. & Obst.*, Aug., 1943, *77*, 178–186.

This article is summarized by the authors as follows:

1. Six cases of triphalangeal thumb have been reported. In 3 of these heredity of the anomaly could be established.

2. This anomaly must be considered rare since the first 3 cases were noted among more than 75,000 draftees examined.

3. None of the various theories advanced at present can be accepted as an adequate explanation for the cause of this anomaly.

4. From a review of the recorded cases, including the 6 cases reported here, it appears that triphalangism of the thumb may have at least two origins: (*a*) double index or an extra finger fused on the radial side of the hand which lost its thumb, simulating the triphalangeal thumb, (*b*) remnant of one of the phalanges of an incompletely developed bifid thumb, simulating a third phalanx.

5. If these two theories are correct, it follows therefore that in the first the triphalangeal digit is not a true thumb. According to the second theory, the additional phalanx is not a true middle phalanx similar to that of the lesser fingers, but a remnant of the base of one of the phalanges of a bifid thumb. The latter theory is favored by the authors.—*Mary Frances Vastine.*

JONES, DEAN B. March fracture of the inferior pubic ramus. *Radiology*, Dec., 1943, *41*, 586–588.

Increasing attention is being given to the nature of march fractures since the beginning of the war. Three cases are described here in which the fracture was in the inferior ramus of the pubic bone with no history of trauma, no other break in the pelvic ring and the characteristic roentgen findings of march fracture. The roentgenograms are reproduced. They show rarefaction across the inferior ramus with a zone of periosteal proliferation at the margins, most marked on the upper margin.

Only one such case has been described before and that was in Germany. The roentgen findings were the same as in these cases. These march fractures occur in young men of previous sedentary life who have suddenly been inducted into active military training. They do not occur in older trained and conditioned soldiers.

If a soldier reports gradually developing adductor, hip or pelvic pain a roentgen examination of the pelvis should be made at once.—*Audrey G. Morgan.*

WHISTON, GORDON. Congenital dislocation of the hip with special attention to the after-care period and late postreductive results. *Surg., Gynec. & Obst.*, Sept., 1943, *77*, 307–314.

Congenital dislocation of the hip, a clinical entity that might better be expressed as congenital misplacement of the hip for its etiology is still largely a matter of conjecture and theory, is not a rare deformity. It is observed more frequently in certain sections of the United States, particularly in the northern states. Outside of the Western Hemisphere, the largest incidence occurs in Italy and France, and at the Rizzoli Institute in Bologna, 3,216 cases have been treated in 33 years.

Methods of Reduction. The closed method of reduction for congenital dislocation of the hip is used for the majority of patients treated in the clinics from which this series was collected and studied. Forty-four of the 48 cases in this group were treated by the closed manipulative method and the technique described by Lorenz was followed in 41 of these 44 cases. Open operation was performed in only 4 patients in the entire series.

Immobilization. The position of immobilization of the hip following reduction by the Lorenz method was that of marked abduction, flexion, and external rotation. This "frog-leg" or first position was maintained for an average period of approximately four months in this series of cases.

The Lorenz second position of less abduction, less flexion, and slight internal rotation was used in almost all the patients treated by the closed method. This position was also maintained approximately four months.

Classification.

1. Class I cures in the Fairbank classification include those cases in which the head of the femur is in the acetabulum and approaches the normal in size and shape as disclosed by roentgen examination. Of the 48 cases reviewed, 18 belonged to this class. The average age was three years at the time of reduction.

2. Class II cures include those cases which show an equally definite anatomical cure but in which the head of the femur is distinctly abnormal either in the direction of being mush-

roomed, varoid, or of being partly or completely worn away by absorptive arthritis. Nineteen cases were in this group.

3. This class includes the considerable number of cases which fail to maintain reduction and in which the femoral head is changed from a posterior dislocation to an anterior position. The anterior repositions are divided into two groups according to the roentgenological findings: (*a*) anterior reposition I means that there is a fairly well formed rounded head opposite the upper lip of the acetabulum with or without the formation of a false acetabulum at this point. Instability is prominent and pain may be noted; (*b*) anterior reposition II includes all the cases with gross changes in the bones. This usually takes the form of flattening and absorption of the head of the femur and a flattening and condensation of the bone at the site of the upper lip of the acetabulum.

Conclusions. From a study of this series of 48 cases which have been under observation from seven to eighteen years after reduction, it is evident that the group in which patients were treated by closed reduction under the age of five years presented late results far superior to those in the older age groups. A period of postreductive immobilization extending over ten months produced more class I cures in this age group than when a shorter period of plaster fixation was used.—*Mary Frances Vastine.*

MacAusland, W. Russell. A study of derangement of semilunar cartilages based on 850 cases. *Surg., Gynec. & Obst.*, Aug., 1943, *77*, 141–152.

This is a study of 850 cases of derangement of the meniscus in the knee joint.

Etiology. A derangement of the semilunar cartilage is usually the result of an injury in which the femur is suddenly twisted inward while the weight is being borne on the flexed knee with the lower leg fixed in the position of external rotation. The injury is usually incurred in a young person while engaged in an active sport. Older people, and especially those with an arthritic background, are likely to twist the knee in minor injuries.

Age and Sex. Cartilage derangements are most common among men between the ages of eighteen and forty years. The lesion is seldom seen in old age or in childhood.

Pathology.

1. Lesions of the internal cartilage predominate over those of the external because the former is a less mobile structure than the latter due to its relation to the internal lateral ligament and to its firm adherence to the articular capsule.

2. Types of injured cartilages include: (*a*) fracture of the cartilage; (*b*) the hypermobile cartilage is the result of abnormal laxity of the meniscus at its periphery from damage to the capsular attachments; (*c*) complicating pathology—the cartilage in addition to being fractured or loose is commonly found to be thinned or thickened, calcified, frayed, cystic, or showing degenerative changes; (*d*) the congenital discoid meniscus. This type of cartilage represents a lack of normal development. It appears to be peculiar to the external meniscus. In some cases it persists as a complete disc and in others as a disc with an open center over which is spread a thin curtain of tissue.

Symptoms and Diagnosis.

1. History of injury at which time there was acute pain and a feeling that the knee gave way. Often it was impossible to straighten the knee after the injury or else bending was possible only after someone had pulled on the leg.

2. Recurrent attacks of slipping of the knee associated with a feeling of insecurity at all times.

3. Intermittent effusion.

4. Pain and tenderness in the region of the offending cartilage.

5. The absence of cartilage-thrust. (In the normal knee, when the joint is extended, the cartilage may be felt to bulge or thrust outward between the articular surfaces; this thrust is missing when the cartilage is torn and displaced in the joint space.)

6. Locking of the joint.

Differential Diagnosis.

1. Loose bodies may be palpated or visualized on the roentgenogram. If locking is present, it tends to be momentary.

2. Involvement of the infrapatellar fat pad. In this condition, the pad is palpable and tender on pressure and subpatellar crepitation is usually present.

3. Arthritic joints are differentiated by roentgenograms, which show irregularities in contour of the joint. The history is gradual.

4. Crucial ligament injuries are readily differentiated by the presence of abnormal anteroposterior motion in the knee (a shuck).

5. Injury of the internal lateral ligament gives tenderness and pain localized on the me-

dial side of the knee increased by abduction. The joint is never locked.

6. Bone injuries can be distinguished by roentgenography.

Roentgen Findings. In cases of suspected damage to a cartilage, roentgenograms of both knees should be obtained, not that they are of any diagnostic value (unless the cartilage happens to be calcified) but because they are essential to exclude concomitant lesions. Some observers claim to be able to demonstrate the injured cartilage by injecting various contrast media into the joint and others recommend arthroscopy, but the results of such demonstrations are as yet inconclusive.

Treatment is discussed in detail. The factors that may interfere with obtaining a good outcome by operative intervention are discussed. Among these are the presence of arthritic changes or associated pathology in the joint and the persistent weakness of the quadriceps extensor.—*Mary Frances Vastine.*

Krause, George E., and Thompson, John R., Jr. March fracture of the tibia. *Radiology*, Dec., 1943, *41*, 580–585.

The most common site of fatigue fracture due to marching is in the metatarsals but it may also be seen in the tibia, most frequently at the junction of the upper and middle thirds on the medial surface. Such fractures have been rare in this country because we have not had compulsory military training. They will probably become more frequent now. A number of European articles on the subject are quoted.

Four cases are described and illustrated with roentgenograms. Attention is called to the fact that differentiation between such fatigue fractures and osteogenic sarcoma may present some difficulty.

These fractures are generally incomplete, extending only through the cortex, and the fracture line is narrow and hard to demonstrate. In one of the cases described the fracture was complete. There is abundant callus formation which occurs early.—*Audrey G. Morgan.*

Love, J. Grafton, and Walsh, Maurice N. Protruded intervertebral disks. *Surg., Gynec. & Obst.*, Nov., 1943, *77*, 497–509.

Protruded intervertebral disks as such have been recognized and their clinical importance has been established since the work of Mixter and Barr in 1934. The facts in this study which are of interest to the roentgenologist are outlined.

Anatomy of the Intervertebral Disks. The disk is composed of the central semigelatinous nucleus pulposus and the outer more fibrous annulus fibrosus. It is applied to the surface of the cartilaginous plate which covers the vertebral body and is bounded anteriorly by the anterior longitudinal ligament and posteriorly by the posterior longitudinal ligament.

Pathology and Etiology of Protruded Disks. The protruded portion of an intervertebral disk practically always consists of both nuclear and annular material. The condition is due to trauma, which is most often associated with the lifting of unusually heavy objects.

Incidence of Protruded Intervertebral Disk. The chief of the Section on Orthopedic Diagnosis and his associates at the Mayo Clinic were called on, in 1940, to see approximately 5,500 patients who had backache as a symptom. Approximately 13 per cent of the 5,500 patients were found to have one or more protruded disks as the cause of their complaints.

Diagnosis of Protruded Intervertebral Disk. Some of the findings on examination of the patient include: (1) loss of lumbar lordosis; (2) tenderness over spinous processes of lower lumbar vertebrae; (3) hyperextension of back limited and extremely painful; (4) straight leg raising in the dorsal recumbent position limited and painful; (5) positive Kernig's sign; (6) tenderness on pressure along course of sciatic nerve; (7) Achilles reflex diminished or absent; (8) history of intermittent pain ever since unusual strain on back; (9) pain aggravated by lifting, coughing, sneezing or straining at stool and disturbing patient's sleep.

Contrast Media in the Diagnosis and Localization of Protruded Disks. As the authors' experience has increased they feel that their clinical diagnosis is just as accurate as the roentgenoscopic diagnosis obtained by the aid of radiopaque oil and more accurate than that obtained by the aid of air. Because of the slow absorbability of radiopaque oil and the medicolegal complications which might follow its employment, its use has been practically abandoned. One of the most important uses of the air myelogram in this group of cases is to exclude an unsuspected intraspinal neoplasm and the presence of multiple lesions. Air is practically valueless in thoracic and cervical intraspinal lesions. Its use is restricted almost en-

tirely to those cases in which a lesion in the lumbar portion of the spinal canal is suspected. The interpretation of spinograms (air myelograms) is very difficult and there are many pitfalls.—*Mary Frances Vastine.*

Ehrenhaft, J. L. Development of the vertebral column as related to certain congenital and pathological changes. *Surg., Gynec. & Obst.*, March, 1943, *76*, 282–292.

The development of the vertebrae and the intervertebral discs is described and a correlation is made between developmental peculiarities and certain lesions found in later life. The lesions found in later life which are discussed include:

1. *Congenital synostosis* (*block vertebrae*). There is complete or partial congenital bony fusion of two or more vertebral bodies without evidence of any or only small amounts of interposed intervertebral disc tissue. This malformation is on the basis of a complete regression of the primitive annulus fibrosus.

2. *Sagittal cleft vertebrae.* Persistence of the ventrodorsal extension of the perichordal sheath with or without the persistence of the chorda or splitting of the notochord in this area may prevent fusion of the laterally situated cartilaginous vertebral halves. Each half may become ossified separately by its anterior and posterior centers with persistence of the sagittal cleft. With weight bearing in later life, such vertebrae may form the "butterfly vertebral bodies."

3. *Lateral half vertebrae or wedge vertebrae.* At first these half vertebrae are cuboidal in shape but they become a wedge as soon as weight bearing occurs. Bilaterally occurring half vertebrae may involve large segments of the spinal column as wedged hemivertebrae at different levels. They are most commonly explained on a faulty shift occurring in the period of development. This unilateral occurring shift will cause an anlage for a half vertebra to remain at the lower and also at the upper end of the unequally shifted vertebral column.

4. *Ventral and dorsal half vertebrae.* These are rare. The explanation for these must be on the basis of faulty vascularization and agenesis of either the anterior or posterior center of ossification. The deformity resulting will be of the gibbous type.

5. *Malformations of the chorda and chordal remnants.* During the state of migration of the notochordal cells during the cartilaginous period of embryonic development, there is definite persistence of the perichordal sheath forming the mucoid streak. Anywhere along the course of this structure which normally regresses completely during the ossification of the vertebral bodies, chordal cell remnants may be found. One of the more frequent abnormalities seen are the outpouchings of the otherwise normal intervertebral discs. Sometimes true extensions of the nuclear material in a wedge-like manner can be seen protruding into the vertebrae. During postmortem examinations notochordal tissue remnants are present in 2 per cent of the cases. Most of these are found in the region of the clivus at the base of the skull.

6. *Congenital weaknesses of the cartilage plates.* In areas where the cartilage plates are penetrated by vessels from the vertebrae, mostly along the peripheral two-thirds and in the center where the axial vessels accompany the notochord, chondrification gaps develop. Multiple spongiosal nuclear prolapses with juvenile kyphosis in the young adolescent group occur mostly in boys subjected to very heavy manual labor. At this age there is still good blood supply to the intervertebral disc tissue. The nucleus pulposus is still rather liquid and easily displaced.—*Mary Frances Vastine.*

Toth, Benedict J., and Wintermantel, Joseph A. An apparently solitary myeloma of bone with subsequent generalization. *Radiology*, Nov., 1943, *41*, 472–477.

Solitary myelomas are rare and apparently less malignant than the more common multiple forms. There are two types. The first is a purely osteolytic lesion with sharp demarcation and little if any expansion, usually located in a single vertebra or the shaft of a long bone. The second is a giant cell type which shows less tendency to generalization and responds better to irradiation.

A case of the latter type is described in a woman aged fifty-three. She had had pain in the right hip for three years before coming for treatment. Roentgen examination on October 20, 1939, showed a solitary tumor of the right pubic bone which later extended to involve the right ischial, innominate and left pubic bones and the soft tissues. At this time chest examination was negative.

On October 31, 1941, roentgen treatment was begun: fifteen treatments were given with a total of 1,700 r through three portals. This was

followed by considerable improvement with increase in red cells and hemoglobin, and in April, 1942, there was considerable recalcification of the area of destruction. A severe reaction with chills and high temperature followed comparatively small doses of roentgen rays. Holzknecht believed such reactions were toxic in character and of good prognosis.

In June, 1942, this patient was readmitted with severe pain in the chest. Roentgenograms of the pelvis at this time showed further improvement but those of the chest showed osteolytic lesions of the ribs with two healing pathological fractures. The patient grew worse rapidly and died on October 28, 1942, three years after the first roentgen study and six years after the beginning of pain in the hip. It is probable that a definite diagnosis of solitary myeloma cannot be made from roentgen examination alone.—*Audrey G. Morgan.*

Echternacht, Arthur P. Pseudotumor of bone in hemophilia. *Radiology*, Dec., 1943, *41*, 565–572.

A case is described in a boy of thirteen who had shown evidence of hemophilia since he was six years of age. This admission to hospital was for a swelling just below the left knee on the anterior surface of the tibia covered with necrotic skin. From roentgen examination a diagnosis of sarcoma of bone was made and roentgen treatment given. The swelling continued to increase in size and extended downward. Disarticulation of the knee joint was decided on. The patient died three days later.

Examination of the specimen showed a large subperiosteal hematoma with massive necrosis of the underlying bone and necrosis and infection of the overlying skin. Evidently the hemophilia had caused subperiosteal hemorrhages which resulted in thickening and proliferation of the periosteum, erosion of the underlying bone and organization and calcification of the hematoma, producing a roentgen image that resembled that of sarcoma.

Three similar cases have been reported in the literature, 2 involving the femur and 1 the bones of the thumb. They are reviewed briefly.—*Audrey G. Morgan.*

BLOOD AND LYMPH SYSTEM

Mahorner, Howard. A method for obtaining venograms of the veins of the extremities. *Surg., Gynec. & Obst.*, Jan., 1943, *76*, 41–42.

Roentgenographic visualization of the veins of the extremities by contrast media is becoming increasingly popular both for the study of relatively recent thrombosis and of long standing occlusion of the deep venous system.

A method is described which obviates the cutting down on the saphenous vein which has heretofore been done in venography of the lower extremities. The method consists of the following steps:

1. The patient sits on the roentgen table and with the legs dependent a 20 gauge needle is inserted into a vein on the dorsum of the foot or on the ankle. The course of the internal saphenous is anterior to the internal malleolus and it is relatively superficial, usually permitting the insertion of a needle without an incision.

2. The tubing of an infusion set containing normal salt solution is connected with the needle. The infusion is permitted to drip relatively rapidly.

3. The patient lies down on the table and a gum rubber tourniquet is applied around the leg, usually at the junction of the middle and lower thirds, sufficiently tight to impede circulation in the superficial veins. This serves to shunt the infusion from the superficial into the deep system.

4. Twenty cubic centimeters of diodrast (35 per cent) is slowly injected into the tubing of the infusion just above the needle.

5. Five seconds after the diodrast is completely delivered, the roentgen exposure is made.

6. After the exposure the infusion continues to run for 200 cc. in order to wash the diodrast from the veins.—*Mary Frances Vastine.*

Baker, E. C., and Sedwitz, S. H. Observations on venography of the lower extremities. *Radiology*, Nov., 1943, *41*, 451–458.

An excellent method of studying the veins of the lower extremities is by a series of multiple roentgenograms made over varying periods of time. The authors used diodrast injected slowly over a period of two minutes. They place two lead screens, one on either side of the top of the Bucky table, wide enough so that the space between them allows a coverage of half of a 14 by 17 inch film. The screens are long enough to reach from the lower abdomen to the ankles. Three pairs of exposures are made. the first covering the ankle and lower leg, the second the upper leg and knee and lower thigh, and the third the upper thigh and lower pelvis.

The anatomy of the veins of the lower limb

is reviewed. Physiological observations can be made from these serial roentgenograms and valuable pathological conclusions drawn. The passage of the dye upward is retarded in severe varicosities and in veins that are dilated and tortuous. There are free anastomoses between the deep and superficial veins of the leg and dye may pass from the one to the other rapidly. Retrograde flow of the dye has been seen in both deep and superficial block. This method should be used before injecting any sclerosing solution or performing any surgical operation. Up until a year ago when the authors first started venography they had 10 per cent post-operative complications following massive injection and ligation and section of the long saphenous vein. Since beginning venography before operating there have been no such complications in 120 cases. The method is also valuable in traumatic phlebothrombosis. There is no danger of diodrast causing loosening of an embolus. The method should be better known to surgeons.—*Audrey G. Morgan.*

Figi, Frederick A., and Watkins, Charles H. Hereditary hemorrhagic telangiectasia. *Ann. Otol., Rhin. & Laryng.*, June, 1943, *52*, 330–341.

Hereditary hemorrhagic telangiectasia is an inherited abnormality characterized by the presence of localized angiomas or telangiectases which have a tendency to bleed. These vascular lesions occur most frequently in the nasal and oral mucous membranes where they often give rise to severe and at times fatal hemorrhage. The entity was first recognized by Rendu in 1896 and was elaborated upon five years later by Osler. In 1934, Houser directed attention to this disease and reported the case of 4 patients all of whom were blood relatives.

During the past twenty years, 20 cases have been recognized at the Mayo Clinic. None of these patients were blood relatives. No demonstrable changes in the coagulation factors of the blood nor undue bleeding after surgical procedures was encountered. In all of the cases seen at the Mayo Clinic, epistaxis was the presenting complaint.

Differential diagnosis must be made from hemophilia, purpura hemorrhagica, aplastic anemia and acute leukemia.

The disease is due primarily to a defect of the walls of the capillaries and venules and therapy is not likely to benefit this. Electrocoagulation has given the best results with the authors. Radium is contraindicated as it is felt that the atrophy and dryness of the nasal mucosa which results greatly increases the tendency to later bleeding.—*Mary Frances Vastine.*

ROENTGEN AND RADIUM THERAPY

Barner, John L. X-ray therapy in the Army. *Radiology*, Nov., 1943, *41*, 483–485.

The author who is a Major in the Army Medical Corps discusses the changes that have taken place in roentgen-ray service since the beginning of the war. Roentgen therapy is now used to some extent throughout the whole Army Medical Department. The roentgen machine used in the combat zone is a portable roentgenographic unit which may be used also for superficial therapy, as for infections and dermatoses. The great majority of cases that require roentgen treatment reach the General Hospitals where there is every facility for proper treatment, as in civilian hospitals. There are now 7 General Army Hospitals in the United States and two outside the country in which both deep and superficial roentgen treatments are given. The names and locations of these hospitals are given and the equipment and treatment discussed.

Calculated on Army statistics for the past in an army of five million men there will be about 2,000 to 3,000 cases of cancer per year and 10,000 cases of non-malignant tumors. There is also now a much larger number of women in the Army than ever before and this will increase the number of cancer cases. Because of the close observation of men in the Army, which is not possible in civilian practice, many cases will be seen earlier in the curable stage, so that the men may be returned to duty. Here in this army of millions the principle of early recognition and early treatment of cancer can be practiced as never before.—*Audrey G. Morgan.*

Pfahler, George E. A review of the Scott wide field x-ray treatment. *Radiology*, Nov., 1943, *41*, 468–471.

Scott's method consists of treatment with small doses of low voltage roentgen radiation applied from the head to the upper part of the lower extremities, both in front and behind. It is given for its tonic and stimulating effect on the body as a whole and not for the destruction of pathological tissue. The dosage and interval between treatments must be determined by this tonic effect.

Scott began this work in 1920–1921 at the London Hospital. The first 50 cases were kept under observation for a year to see that no harm was done. Not only were there no bad effects but there was distinct improvement in all cases. There was nothing to suggest anemia or leukopenia in any case.

The differential sedimentation test has been found of value in testing results and determining the saturation point. The author has been using this method for more than six months and has seen no harm and some benefit from it.

In the discussion Dr. Helen B. Flynn of Chicago said that in this treatment the patient must be watched carefully for signs of toxemia. Each patient will respond differently. Dr. Gendreau of Montreal said they had been using the method in the Montreal Hospital but that it is dangerous and must be carefully studied. Dr. Godfrey of Glendale, California, said he had seen no bad effects from the treatment. He believed that in the cases in which bad effects had been reported curious metabolic changes had occurred which released toxic substances that acted as a systemic poison. Dr. Pfahler, in closing, emphasized the fact that this was a stimulating treatment for normal tissue and not a destructive one for pathological tissue. It has no relation to the high voltage body treatment given for leukemia. The effect of any dose of roentgen rays depends to a great extent on the volume irradiated. Naturally when the whole body is irradiated the constitutional effect is very great and this must be taken into consideration. Low voltage irradiation does not injure the blood-forming organs.—*Audrey G. Morgan.*

Rosh, Rieva, and Quinn, William P. Roentgen rays in the treatment of cervical lymphadenitis. *Radiology*, Nov., 1943, *41*, 464–467.

The follow-up of 419 patients with cervical lymphadenitis treated at Bellevue Hospital has shown the good effects of irradiation in this condition. Small doses of roentgen rays are known to have a good effect on inflammatory conditions. A standard method of treatment for all cases is not possible. In children and younger patients with superficial lesions, low or medium voltage treatment was given. In patients with deep large nodes, particularly if several nodes had become confluent, high voltage deep treatment was used. The total dose given was 700 to 900 r, in air, repeated if necessary after six to eight weeks.

Regression and healing of the nodes and sinuses was usually complete. All types and stages of cervical adenitis were treated.

Roentgen examinations of the chest were made in all cases. It was found that there was no active pulmonary tuberculosis unless the supraclavicular, axillary or mediastinal nodes were involved.

The results are of course influenced by the economic condition of the patients. Run-down, overworked and poorly nourished patients do not respond as well as those in better condition. —*Audrey G. Morgan.*

McFarland, Joseph. The mysterious mixed tumors of the salivary glands. *Surg., Gynec. & Obst.*, Jan., 1943, *76*, 23–34.

The mixed tumor was first described by Virchow in 1863. It is not a common finding since the author has been able to find only 400 cases in a twenty-five year search.

These tumors have the following characteristics:

1. They are definitely encapsulated and do not infiltrate unless their capsule is opened.
2. The tumor usually projects externally but the skin stretches over it and rarely ulcerates.
3. One hundred of the writer's 400 cases have recurred.
4. Every mixed tumor consists of interstitial and parenchymatous tissues, the proportions and conditions of which vary.
5. Metastasis is extremely rare. Perhaps it never occurs.
6. Local interference with function is rare.
7. Treatment with roentgen rays and radium has not proved of benefit.

Excision of the tumor is indicated only if:

1. The patient insists on the operation because of the disfigurement. (He should be advised of the possible sequelae, viz., salivary fistula, facial palsy, or recurrence.)
2. Limitation of mandibular movement which makes opening of the mouth difficult.
3. Pain from pressure upon the sensory nerves.
4. Sudden rapid increase in the size of the tumor.—*Mary Frances Vastine.*

Buckman, Lewis T. Carcinoma of the middle ear and mastoid. *Ann. Otol., Rhin. & Laryng.*, March, 1943, *52*, 194–201.

A case of carcinoma of the middle ear and mastoid is reported and a discussion of this entity is presented. Statistics vary from an incidence of 1/4000 to none in 20,000 cases. The following conclusions are reached:

1. Carcinoma in this location is usually preceded by a long period of otorrhea.

2. Homolateral seventh nerve paralysis is usually an accompaniment sooner or later.

3. There may be polypoid tissue in the middle ear which is friable and perhaps, grayish.

4. Pain is late.

5. Roentgen examination may not be helpful. It usually is not.

6. Treatment is unsatisfactory. In 1930, Fraser described his sleeve operation on the canal and the postoperative use of radium. He felt that if the mastoid was involved in the carcinomatous process there was little hope. In 1935 Schall described a technique of wide removal of the cutaneous nerves and the canal together with radical mastoidectomy followed by irradiation. His results were favorable.—*Mary Frances Vastine.*

Fisher, Gilbert E. The use of radium in conduction deafness. *Ann. Otol., Rhin., & Laryng.*, June, 1943, *52*, 473–476.

Akaiwa and Takeshima in 1930 carried out experiments on the effects of irradiation of the lymph nodes found in the popliteal spaces of rabbits. Thirty minutes after irradiation, the lymph follicles of these nodes were enlarged. After one hour, the nuclei of many of the cells began to disintegrate. This disintegration reached its height in two to six hours. From this time on, marked phagocytosis was noted. Because of this disintegration of lymphocytes there was a considerable decrease in the number of these cells in the lymph follicles after forty-eight hours. Then followed regeneration so that after the seventh day the lymph node resumed its normal appearance except for an increase in connective tissue. Microscopically there was an increase in the size of the node for the first two hours following irradiation. Then there was a gradual decrease in the size of the node, and in two weeks, the node was smaller than normal.

The author has used a radium applicator in the treatment of 45 cases of conduction deafness in which lymph tissue was noted to be obstructing the eustachian tube. The capsule is made of platinum 0.5 mm. in thickness and this is loaded with 50 mg. of radium. The capsule has a coating of rubber 0.7 mm. in thickness. A 1 per cent solution of cocaine is sprayed into each inferior meatus. A cotton-tipped applicator moistened with 3 drops of 10 per cent cocaine is then passed along the floor of each inferior meatus. After five minutes, the radium applicator is inserted into the nasopharynx. A 2-gram minute treatment is given on each side.

Following the treatment there may be some stuffiness for one week with some increase of post-nasal discharge. This is followed by a decrease in the amount of the post-nasal discharge.

Conclusions.

1. Nasopharyngeal lymph tissue will undergo compensatory hypertrophy producing a large recurrent mass of adenoids and a "granular" pharyngitis in almost every child whose adenoids have been removed prior to puberty.

2. Large masses of nasopharyngeal tissue which obstruct the eustachian tubes are definite etiologic factors in conductive deafness.

3. Atrophic changes can be readily produced in this tissue by exposing it to the gamma rays of radium.—*Mary Frances Vastine.*

Jackson, Chevalier L., and Blady, John V. Criteria for the selection of treatment of cancer of the larynx. *Arch. Otolaryng.*, May, 1943, *37*, 672–679.

Much has been written about the relative advantages of irradiation and surgery in the treatment of cancer of the larynx, and too often these two methods have been considered from a competitive standpoint.

The authors' criteria for the selection of a method of treatment of cancer of the larynx are:

1. The presence or absence of cervical metastases.

2. The location and extent of the lesion, as evidenced by its appearance on direct and indirect laryngoscopy and by lateral and planigraphic roentgenographic study.

3. The motility and mobility of the laryngeal structures.

4. The histologic character of the lesion.

5. The general physical condition and temperament of the patient.

The indications for laryngofissure and laryngectomy include:

1. Lesions occupying the middle third of one vocal cord are suitable for laryngofissure by the "clipping" technique.

2. Lesions reaching the anterior commissure and even involving the opposite cord are amenable to extirpation by the laryngofissure route.

In such cases the "anterior commissure" technique should be used.

3. Lesions in which the growth is cordal but has reached the posterior end of the cord and produced impairment of motility, or has extended subglotically, ordinarily call for total laryngectomy.

4. Lesions in which the tumor has invaded cartilage (but not muscles) also call for laryngectomy, provided there are no metastases.

The indications for irradiation include:

1. Lesions unsuitable for laryngofissure and for which laryngectomy is contraindicated by the age, physical condition or temperament of the patient.

2. "Inoperable" growths which are extrinsic by origin or extension or which have cervical metastases.

3. Lesions which have reached the posterior extremity of the cord but have not produced impairment of motility of the cord.

There are those who minimize the importance of the histopathologic picture, but the authors believe that the ultimate prognosis will be most favorable in cases of the better differentiated, slower growing, lower grade tumors, regardless of the method of treatment. In a recent review of cases of patients treated by irradiation alone, 95 per cent of patients with Grade 1 tumors, 70 per cent with Grade 2 tumors and only 40 per cent with Grade 3 tumors survived five years or more.—*Mary Frances Vastine.*

New, Gordon B., and Stevenson, Walter. End results of treatment of malignant lesions of the nasopharynx. *Arch. Otolaryng.*, Sept., 1943, *38*, 205–209.

Two hundred and seventy-one patients suffering from malignant lesions of the nasopharynx received treatment. Biopsy was made in all cases and all revealed evidence of malignancy except 37. In these 37 cases there was a definite clinical picture of malignant disease but one biopsy did not reveal the malignant cells. However, the subsequent course of the disease confirmed the clinical diagnosis. Most of the malignant tumors of the nasopharynx are epitheliomas, usually high grade squamous cell epitheliomas Grade 4 (Broders' method), which, fortunately, are radiosensitive. The epitheliomas usually appear as ulcerative lesions in Rosenmüller's fossa while the lymphosarcomas are large bulky tumors. The youngest patient was four years of age and the oldest eighty with an average of 43.3 years.

The 234 patients with malignancy proved by biopsy were treated by irradiation. Symptomatic relief following treatment by irradiation was sometimes striking. The pain and headache were much better or sometimes entirely cleared up. Double vision, due to palsy of the sixth nerve, was eliminated by the treatment in some cases. Deafness from obstruction of the eustachian tube by pressure of the tumor was improved. Lymph nodes of the neck were often reduced in size so that the patient was much better and more comfortable at least for a time. In several cases roentgenograms of the sella showed destruction of the posterior clinoid processes from extension of the tumor. After treatment, regeneration of the bone occurred in a remarkable fashion.

Of the patients who had sarcoma, 26.8 per cent were alive five years after treatment and of the patients who had squamous cell epithelioma 8.9 per cent were alive. Of the total number of patients who had malignant lesions, 13 per cent were living after five years. About twice as many patients with squamous cell carcinoma were alive in the group without involvement of the lymph nodes at the time of the treatment as in the group with such involvement. In other words, 15.6 per cent of the patients with squamous cell carcinoma who did not have palpable lymph nodes and 7.4 per cent of the patients who had palpable lymph nodes were alive five years after treatment.—*Mary Frances Vastine.*

Engler, Clarence W. Roentgen therapy of laryngeal tuberculosis. *Ann. Otol., Rhin. & Laryng.*, Sept., 1943, *52*, 655–665.

The most popular local measure in use today for the treatment of laryngeal tuberculosis is electrocauterization (voice rest excepted). It is universally agreed that laryngeal tuberculosis is practically always secondary to pulmonary tuberculosis.

Rickmann has classified laryngeal tuberculosis as follows:

1. Productive or proliferative type in which the lesion is fairly well defined and localized. A tendency toward healing is present.

2. Exudative type. The lesions are diffuse so that several structures in the larynx may be the seat of disease at the same time.

3. The mixed type in which both productive and exudative lesions exist in the same larynx. In all three types, infiltration and ulceration may be present.

Thirty-eight patients were given roentgen therapy. The rationale of the treatment adopted in this series took into account the fact that the inflammatory component could be managed by relatively small doses of roentgen rays and that the chronicity factor could be controlled by multiple doses at relatively long intervals and continued over a period of several months.

Summary and Conclusions.

1. Laryngeal tuberculosis is practically never primary but always a part of the general or pulmonary tuberculosis and must be considered and treated as such.

2. Good general resistance and a successful collapse therapy are more important in healing of the larynx than are any local therapeutic measures.

3. The laryngeal lesion may heal while the pulmonary disease progresses.

4. In a few cases the lung condition improved while the laryngeal lesion remained unimproved or progressed unfavorably.

5. Laryngeal tuberculosis may be divided into the productive, exudative, and mixed types.

6. Opinion regarding the type of laryngeal tuberculosis that will be improved by roentgen treatment varies with the enthusiasm and experience of different authors.

7. The cases reported in this series were not selected. Thirty-eight patients were given roentgen therapy. Of these, there was healing of the larynx in 21 per cent; 16 per cent showed some improvement. Twenty-one per cent remained unchanged and 42 per cent became worse.

8. All 16 cases (42 per cent) in which the larynx became worse were of the exudative type.

9. It is advised that a large series of selected patients be given roentgen therapy in order to determine what relative value it has as compared with other local measures and also what type of lesion is benefited by it.—*Mary Frances Vastine.*

Martin, Charles L. Cancer of the nasopharynx. *Ann. Otol., Rhin., & Laryng.*, March, 1943, *52*, 146–160.

Cancer of the nasopharynx originates most frequently in the pharyngeal tonsil and the fossae of Rosenmüller and much less often in the periphery of the choanae and the posterior nasopharyngeal wall. Many of these are incorrectly diagnosed even after secondary invasion. Woltman stated that only 1 out of 20 cases examined at the Mayo Clinic prior to 1922 had been correctly diagnosed.

Undifferentiated epitheliomas, lymphoepitheliomas, lymphosarcomas and plasmocytomas respond satisfactorily to irradiation whereas adenocarcinomas, well differentiated epitheliomas and the spindle cell carcinomas respond poorly.

The subject is discussed under the following headings:

1. Local growth. Only half of New's 194 cases complained of symptoms produced by the primary growth. Thus, it is usually the manifestations due to the secondary extension which first bring the patient to the physician.

2. Intracranial extension. This occurs in about one-third of the cases. The exact mode of the extension is not known. The neoplasm enters the cranial vault just lateral to the sella in the region of the foramen lacerum and may extend either anteriorly or posteriorly. The dura is pushed upwards but practically never invaded. No dysfunction of the pituitary gland has been seen from this extension. Vertical sections of the middle fossa show the nerves to be placed in the following order if one reads from below upwards: the sixth branches of the fifth nerve, the third nerve, the fourth, the first. Extension of the nerve symptoms due to extension of the tumor into the middle fossa follows the same order. (The posterior cranial nerves are likely to be compressed by extracranial rather than by intracranial metastases.) Auditory nerve symptoms practically never occur. The patient with early intracranial extension usually complains of double vision from internal strabismus, pain or anesthesia in the face, nose or teeth.

3. Lymph node involvement. Those which lie in the deep cervical region below the tip of the mastoid are the first to be involved. There is later dissemination to the posterior cervical chain, and occasionally the submaxillary and submental glands are involved.

4. Generalized metastases. Extension below the clavicles with mediastinal lymph node or pulmonary involvement is not infrequent. Metastases to bones, liver, kidneys, spleen or retroperitoneal lymph nodes are usually present at this stage.

5. Treatment. Surgery has accomplished relatively little in the treatment of these tumors. Approximately 85 per cent of the primary le-

sions are so radiosensitive that they can be completely eradicated by irradiation. The exact technique and dosage used by the author in treatment is outlined. He administers irradiation to the base of the skull and the thorax as well as the lesion itself in the early cases.—*Mary Frances Vastine.*

LENZ, MAURICE. X-ray treatment of diseases of the larynx. *Ann. Otol., Rhin. & Laryng.*, March, 1943, *52*, 85–108.

Roentgen treatment is employed chiefly in three groups of diseases of the larynx, viz., chronic inflammation, benign tumors and cancer.

1. Inflammation of the larynx. The inflammatory diseases in which roentgen treatment has been carried out most often are tuberculosis, blastomycosis and scleroma. (Though roentgen treatment of laryngeal tuberculosis has been popular in central Europe for fifteen years it has not been generally accepted in the United States.)

2. Benign tumors of the larynx. Roentgen treatment of benign tumors of the larynx has been successful chiefly in a few hemangiomas and various types of papilloma. Single papillomas which are uncommon and usually occur in adults should not be treated by roentgen irradiation. The need for roentgen treatment of multiple papillomas in children has been reduced to a minimum as they are now effectively treated by estrogen therapy.

3. Cancer of the larynx. Details of the present technique employed by the author at the Presbyterian Hospital, New York, are given. Eighty-nine cases of carcinoma of the larynx were treated between 1932 and 1936. Of this number, 14 had treatment following total laryngectomy. Four of these (28.6 per cent) were clinically free from cancer in January, 1942. Five received roentgen treatment after partial laryngectomy. Three of these (60 per cent) were clinically free of disease in 1942. Seventy cases received roentgen treatment only and 13 (18.6 per cent) were clinically free in January, 1942.

It is often difficult to decide whether in a particular case of carcinoma of the larynx it is better to perform a laryngofissure and cordectomy, a total laryngectomy or to rely upon roentgen treatment. Roentgen treatment of cancer of the larynx is a serious undertaking. The reaction to it is severe and it is not tolerated by all patients.

Microscopic classification of cancer of the larynx by itself is no longer regarded as a reliable guide either to radiosensitivity or to radiocurability of the process. Prognosis seems rather to be influenced by:

1. The location of the primary tumor. Those which are located primarily in the region of the arytenoid cartilages seem to have the poorest prognosis.

2. Local extent of carcinoma of the cords. There is no doubt that the extent of the cancer on admission definitely influenced the results of roentgen treatment in the series treated.

3. Cancer of the arytenoids. Invasion of the arytenoids by carcinoma whether this is an extension from a primary site on the mucosa covering the arytenoids or is a spread from a cancer of the cord, often signifies that the cancer is incurable by roentgen treatment. Three factors contribute to the gravity of invasion of the arytenoids by cancer: (*a*) cancer of the arytenoids is usually silent early whereas cancer on the free edge of the cords produces hoarseness and therefore an early diagnosis; (*b*) a rich lymphatic network covers the arytenoids so metastasis is early; (*c*) the arytenoids are located in a sort of pouch and drainage is uphill and inadequate. Infection therefore persists here so that necrosis, especially of the cartilages, arises and is made worse by roentgen irradiation.

4. Cancer of the epiglottis. Cure may result from roentgen therapy, even if most of the epiglottis has been invaded by the cancer and has undergone necrosis after roentgen treatment. This is probably because in necrosis of the epiglottis, drainage is downwards towards the ventricle, and the necrotic material is emptied into this cavity whence it is coughed up and expectorated.

5. Metastases to cervical lymph nodes. Naturally those patients whose cancer on admission has already extended beyond the cord tend to present metastatic lymph nodes more often than those in whom it is still limited to the cord.—*Mary Frances Vastine.*